5-A
ODOR AND AIR QUALITY: TREATMENT PLANT

FINAL ENVIRONMENTAL IMPACT STATEMENT

Brightwater Regional Wastewater Treatment System

APPENDICES

Brightwater
TREATMENT SYSTEM

Final

Appendix 5-A
Odor and Air Quality:
Treatment Plant

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King County has prepared a Draft Environmental Impact Statement (Draft EIS) and Final Environmental Impact Statement (Final EIS) on the Brightwater Regional Wastewater Treatment System. The Final EIS is intended to provide decision-makers, regulatory agencies, and the public with information regarding the probable significant adverse impacts of the Brightwater proposal and identify alternatives and reasonable mitigation measures.

King County Executive Ron Sims has identified a preferred alternative, which is outlined in the Final EIS. This preferred alternative is for public information only, and is not intended in any way to prejudge the County's final decision, which will be made following the issuance of the Final EIS with accompanying technical appendices, comments on the Draft EIS and responses from King County, and additional supporting information. After issuance of the Final EIS, the King County Executive will select final locations for a treatment plant, marine outfall, and associated conveyances.

The County Executive authorized the preparation of a set of Technical Appendices, in support of the Final EIS. These reports represent a substantial volume of additional investigation on the identified Brightwater alternatives, as appropriate, to identify probable significant adverse environmental impacts as required by the State Environmental Policy Act (SEPA). The collection of pertinent information and evaluation of impacts and mitigation measures on the Brightwater proposal is an ongoing process. The Final EIS incorporates this updated information and additional analysis of the probable significant adverse environmental impacts of the Brightwater alternatives, along with identification of reasonable mitigation measures. Additional evaluation will continue as part of meeting federal, state, and local permitting requirements.

Thus, the readers of this Technical Appendix should take into account the preliminary nature of the data contained herein, as well as the fact that new information relating to Brightwater may become available as the permit process gets underway. It is released at this time as part of King County's commitment to share information with the public as it is being developed.

EXECUTIVE SUMMARY

The purpose of this Technical Appendix is to present the regulatory requirements, methodology, and analysis of air and odor impacts from the proposed Brightwater Regional Wastewater Treatment Plant (Brightwater Treatment Plant) at the Unocal and Route 9 sites. Regulated air quality compounds and a full suite of odorous compounds are addressed in this Technical Appendix.

Air quality compounds include federal criteria pollutants, federal hazardous air pollutants (HAPs), state toxic air pollutants (TAPs), and federal and state regulated substances. The odorous compounds include hydrogen sulfide, ammonia, reduced sulfur compounds, amines, fatty acids, and other odor mixtures captured by a “total odor” estimate.

Federal, state, and local laws and regulations on air quality and odor are presented, and the Brightwater Treatment Plant’s air and odor emissions are evaluated for each compliance requirement. In addition, odor emissions were evaluated for compliance with King County’s policy of no detectable odor at the property line of the Brightwater Treatment Plant.

The air quality and odor analysis used several common models, emission estimating methodology, and meteorological data. The common models, methodology, and data include:

- Bay Area Sewer Toxics Emissions (BASTE) air fate emissions estimation model, in combination with direct source testing data and emission factors, for determining Brightwater's air emissions from the liquid processes.
- Direct experience and source testing data from existing wastewater treatment plants for estimating the Brightwater Treatment Plant's odor emissions.
- Air quality and odor potency from each process area to determine regulatory, permitting, and prevention needs and compliance approaches.
- Atmospheric dispersion model (ISCST3) to calculate both specific compound and odor emissions concentrations away from a source. For odor dispersion modeling, this model was modified to determine "puff-odor" conditions that could occur over short periods of time (3-minute periods).
- Three meteorological data sets to analyze air quality and odor emissions compliance requirements and offsite impacts. The data sets were Paine Field data and onsite meteorological data for each of the two Brightwater Treatment Plant sites (Route 9 and Unocal).

Odor Prevention Summary

King County is committed to operating the Brightwater Treatment Plant with no detectable odors at the property line 365 days per year, 24 hours per day. To this end, stringent design and performance criteria have been established for odor prevention at the treatment plant. These standards require that odor levels at the property line be less than the initial detection threshold (or first detectability of an odor), including during times of peak odor generation within the plant and worst-case meteorological conditions. The detection thresholds for the odorous compounds (see Table ES 1) are significantly less, and more stringent than, the recognition thresholds, which are the typical standards for most wastewater treatment facilities. Recognition thresholds are those reached when someone smells something that they recognize, like a rotten egg smell, and can correctly identify the substance (e.g., hydrogen sulfide as a sewage-type odor). Odorous compounds below the initial detection threshold are considered nondetectable.

TABLE ES 1
Initial Detection Threshold of Odorous Compounds

Parameter	Initial Detection Threshold
Hydrogen Sulfide (H_2S)	>0.8 ppbV[a]
Ammonia (NH_3)	>2,800 ppbV[a]
Odor	>1 D/T

[a] Threshold based on recent work done by St. Croix Laboratories for Sacramento Regional Sanitation District.

D/T = dilution to threshold
ppbV = parts per billion by volume

Table ES 2 shows the predicted worst-case (peak) odor emissions at the property line. Table ES 3 shows predicted odor concentrations under average conditions at the property line. Both tables indicate that King County's no detectable odor goal would be achieved with a significant factor of safety. Worst-case odor emission estimates are based on using the highest potential odor emission levels and modeling those emissions for 365 days per year, 24 hours a day. The meteorological conditions modeled vary. The worst-case meteorological conditions modeled occur during stagnant (very stable) conditions, or "F" stability class, which include times of very low wind speeds, little change in wind direction, overcast conditions, and temperature inversions.

TABLE ES 2
Brightwater Treatment Plant Peak Offsite Odor Concentrations at 36 mgd (using onsite meteorological data)

Parameter	Initial Detection Threshold	Peak Concentration at Route 9	Peak Concentration at Unocal
Total Odor	1 D/T	0.004 D/T (250 times less than initial detection threshold)	0.02 D/T (50 times less than initial detection threshold)
Hydrogen Sulfide	0.8 ppbV	0.03 ppbV (27 times less than initial detection threshold)	0.2 ppbV (4 times less than initial detection threshold)
Ammonia	2,800 ppbV	0.53 ppbV (5,300 times less than initial detection threshold)	0.68 ppbV (4,100 times less than initial detection threshold)

D/T = dilution to threshold
mgd = million gallons per day
ppbV = parts per billion by volume

TABLE ES 3
Brightwater Treatment Plant Average OffSite Odor Concentrations at 36 mgd (using onsite meteorological data)

Parameter	Initial Detection Threshold	Average Offsite Concentration at Route 9	Average Offsite Concentration at Unocal
Total Odor	1 D/T	0.0002 D/T (5000 times less than initial detection threshold)	0.0001D/T (10,000 times less than initial detection threshold)
Hydrogen Sulfide	0.8 ppbV	0.002 ppbV (400 times less than initial detection threshold)	0.0008 ppbV (1,000 times less than initial detection threshold)
Ammonia	2,800 ppbV	0.018 ppbV (155,000 times less than initial detection threshold)	0.013 ppbV (215,000 times less than initial detection threshold)

D/T = dilution to threshold
mgd = million gallons per day
ppbV = parts per billion by volume

Key odor elements of the Brightwater Treatment Plant odor prevention program are:

- King County is committed and accountable to the Puget Sound Clean Air Agency (PS Clean Air), State of Washington, and Brightwater Treatment Plant's neighbors to meet the criteria of no detectable odor at the property line.
- Brightwater Treatment Plant's goals for odor prevention are the most stringent in the United States.
- The proposed odor prevention system selected would use best available control technology (BACT) and be the most advanced in the United States. Treatment Plant features are described below:
  - Three-stage chemical scrubbing followed by activated carbon scrubbing would be used.
  - All treatment processes would be covered or enclosed to capture and treat process air.
  - Liquid-phase treatment would be provided in the collection system and at the influent pump station to reduce the formation of odors, further reducing downstream treatment plant odor loading.
  - Odor prevention systems would be sized to handle worst-case operating conditions, when combinations of meteorological conditions (such as inversions and stagnant air, which tend to occur in the autumn and winter) coincide with peak odor releases from treatment processes (which tend to occur in the summer). In reality, the two events are not expected to occur at the same time.
  - Redundant equipment would be included in the treatment plant design to ensure that the odor criteria are met during periods of equipment failure.
  - Additional permanent air scrubbers would be provided and used during any maintenance activity that requires cleaning the covered process equipment or building. This would ensure that no foul air would be released into the atmosphere during tank cleaning, inspection, and maintenance.

Air Quality Compliance and Prevention Summary

Air quality emissions (HAPs, TAPs, and criteria pollutants) would be generated in the wastewater treatment processes and during combustion of fuel gases used in the treatment plant. Wastewater treatment emissions are typically volatile organic chemicals that are present in the influent wastewater and are released from the liquid or sludge in the treatment process. Typically, these emissions are released to the atmosphere. However, in the case of the Brightwater Treatment Plant, where all process units are covered, these emissions would be vented through the odor prevention system. For this analysis, no credit for air emissions reductions of nonodorous compounds was given for the three-stage chemical scrubbing and carbon scrubbing system. Air emissions from combustion sources would be controlled in several ways, including requiring low-emissions burners or equipment and/or add-on air emissions abatement equipment.

The treatment plant air emission estimates from the liquids, solids, and combustion sources indicate that all air emissions, except potentially chloroform, would be less than regulatory requirements and are therefore not expected to have an adverse impact on human health and the environment.

Chloroform impacts were predicted to be above the Washington State Department of Ecology and the PS Clean Air's acceptable source impact level (ASIL) in all scenarios modeled for both potential treatment plant locations. Chloroform emissions above the ASIL are typical for wastewater treatment plants due to the chlorine used in drinking water that is eventually discharged to the wastewater system and volatilizes during the wastewater treatment process. The carbon in the odor prevention system is expected to remove some chloroform as well as other air-quality-related substances. However, the percent of chloroform removal provided by the carbon has not been determined at this time. An evaluation of the chloroform removal efficiency of the carbon, and its feasibility as a control device for chloroform, is currently being conducted. If it is not technically feasible to control chloroform using carbon or some other control technology to levels that meet the ASIL, then a second-tier analysis would be conducted and submitted during the permitting process. The second-tier analysis uses a health impact assessment instead of ASIL. Because chloroform emissions are typically above the ASILs at wastewater treatment plants, it is common to do a second-tier analysis, and generally this assessment has shown little to no health risks due to chloroform.

Air emissions summaries for each location (Route 9 and Unocal) are found in this Technical Appendix. These emission summaries were used to evaluate air quality compliance requirements for initial and final buildout wastewater flows for each site. These estimates were based on emissions parameters taken from Brightwater Treatment Plant's layout as shown in the Final EIS, design and emissions data developed from similar wastewater treatment plants, emission factors for combustion sources (from AP-42, the U.S. Environmental Protection Agency's [EPA's] compilation of emission factors for stationary sources), and emission factors for liquids and solids processes (from the BASTE model). To fulfill the air quality regulatory and legal requirements for the treatment plant, the Brightwater Treatment Plant would be required to:

- File a Notice of Construction (NOC) application and receive an Order of Approval permit under Section 6.07 of Puget Sound Clean Air Regulation I, Article 6: New Source Review.
- Apply for and receive an Air Operating Permit in compliance with the Washington Clean Air Act, Chapter 70.94 revised Code of Washington (RCW), Chapter 173-401 of the Washington Administrative Code (WAC), and Puget Sound Clean Air Regulation I, Article 7.

The Brightwater Treatment Plant would be required to get a NOC, but would not be required to have a federal Title V operating permit because it would likely emit less than 100 tons per year of any criteria pollutant and less than 10 tons per year of any single HAP, or 25 tons per year of any combination of HAPs. Both permitting programs are implemented by PS Clean Air and would be addressed when air quality permit applications are submitted.

As part of the NOC application process, new emission sources must also comply with all state and local emission standards. New emission sources of criteria pollutants must apply BACT, and new emission sources of toxic air pollutants must apply best available control technology for toxics (TBACT), as defined by PS Clean Air. Because the treatment plant would not be expected to be a major source of HAPs, federal maximum achievable control technology (MACT) standards would not be applicable to this treatment plant.

The treatment plant would be required to submit an annual emission inventory to PS Clean Air. The emission inventory would report the annual emissions of criteria pollutants or air contaminants, which include nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOCs), sulfur oxides (SOx), and particulate matter (PM). The treatment plant would also be required to report emissions of TAPs and HAPs. Currently, facilities are not required to report emissions of the greenhouse gases carbon dioxide and methane, but this may change in the next few years if the regulatory agencies adopt specific standards, regulations, or reporting requirements focused on greenhouse gases.

Combustion sources planned for the treatment plant (co-generation turbines, diesel generator, boilers, and an emergency flare) would be equipped with BACT to control emissions within regulatory requirements.

1 INTRODUCTION

The Brightwater Regional Wastewater Treatment System (Brightwater System) has been proposed by King County to address the needs of the growing region. The Brightwater System would protect human health and the environment by minimizing the risk of sanitary sewer overflows from a wastewater collection and treatment system that would meet its capacity by 2010.

This Technical Appendix was developed to quantify the offsite odor and air quality impacts generated by the proposed Brightwater Treatment Plant. Odors, criteria pollutants, hazardous and toxic air pollutant emissions, and ambient air impacts that could result from the construction and operation of the Brightwater Treatment Plant are all discussed herein. Both the Route 9 and Unocal sites were analyzed. Odor and air quality impacts related to the conveyance system are discussed in Appendices 5-B (Odor Analysis: Conveyance) and 5-C (Construction-Related Air Impacts: Conveyance).

The analyses and methodology described in this Technical Appendix follow a proven approach that has been used successfully in the past at several wastewater treatment plants. The analyses followed these steps:

1. Establish design criteria and standards.
2. Determine air flows.
3. Determine odor and air toxic quantities and control requirements.
4. Find the best available solution for odor prevention and air quality control.
5. Show the results using proven and accepted models.

This Technical Appendix has six sections:

- **Executive Summary.**
- **Section 1** provides an introduction to the Technical Appendix.
- **Section 2** covers both air and odor emissions regulatory environment, including applicable laws and regulations.
- **Section 3** addresses all elements that are common for both air quality and odor emissions analysis, including the plant as seen from an air quality perspective, common models, and emission factors.
- **Section 4** discusses odor impacts resulting from the Brightwater Treatment Plant.

- **Section 5** addresses air quality impacts from the Brightwater Treatment Plant.

Several attachments that support these sections are provided at the end of this Technical Appendix, including a list of focus compounds of interest, modeling results, and emission parameters. Specifically, the attachments include:

Attachment A – Hazardous Air Pollutants
Attachment B – Toxic Air Pollutants
Attachment C – Chemicals Requiring Risk Management Plans
Attachment D – Influent Concentrations used in Air Toxics Emission Modeling
Attachment E – Combustion Source Parameters
Attachment F – Liquids and Solids Process Source Parameters
Attachment G – Acronyms and Abbreviations

2 AIR QUALITY REGULATORY ENVIRONMENT

2.1 Introduction

This section gives an overview of the regulations involving odor and air quality that would affect the Brightwater Treatment Plant. Applicable regulations are briefly discussed, and then each air quality parameter is discussed in detail. A discussion of permitting requirements and project-specific regulatory requirements concludes this section.

2.2 Overview of Air Quality and Odor Regulations

Air quality standards in the United States are mandated by the Clean Air Act and its amendments. Three agencies currently have jurisdiction over air quality in King and Snohomish Counties: the U.S. Environmental Protection Agency (EPA), the Washington State Department of Ecology (Ecology), and the Puget Sound Clean Air Agency (PS Clean Air). Each agency has developed its own air quality standards under the Clean Air Act, but the standards are similar among the agencies. EPA standards generally apply unless a more stringent standard for the source or type of pollutant has been adopted by the state or local agency.

Three general types of air quality pollutants are regulated by federal, state, and regional air quality agencies: criteria pollutants, hazardous air pollutants, and toxic air pollutants. A fourth type of air quality indicator—odor—is not specifically addressed under federal air quality regulations, but is broadly addressed under Washington State regulations and more specifically addressed under PS Clean Air regulations. Each type of pollutant, and the regulations affecting it, is described below. Substances regulated under the federal Risk Management Plan (RMP) program are also described. This is followed by a discussion of air quality permit requirements for new sources of air emissions.

2.2.1 Criteria Pollutants

The federal Clean Air Act requires that EPA's Office of Air Quality Planning and Standards set National Ambient Air Quality Standards (NAAQS) for six principal pollutants, called "criteria" pollutants. Most of these pollutants are commonly referred to by their abbreviations, which are used in this section for consistency with regulatory nomenclature. The six criteria pollutants currently regulated by the NAAQS are:

1. Carbon monoxide (CO)
2. Sulfur dioxide (SO_2)
3. Lead
4. Ozone
5. Various categories of particulate matter, including:
   - Particulate matter less than 10 microns in size (PM_{10})
   - Particulate matter less than 2.5 microns in size ($PM_{2.5}$)
   - Total suspended particulate (TSP)
6. Nitrogen dioxide (NO_2)

EPA has identified two types of standards for these pollutants:

1. Primary ambient air quality standards, which define levels of air quality necessary to protect public health with an adequate margin of safety.
2. Secondary standards, which define levels needed to protect the public welfare from any known or anticipated adverse effects of a pollutant.

Such standards are subject to revision, and additional primary and secondary standards may be promulgated as EPA deems necessary to protect the public health and welfare. In addition, Washington State administers its own standards (through PS Clean Air), some of which are more stringent than EPA standards. Table 1 lists the national, state, and local Ambient Air Quality Standards.

TABLE 1
National and State Ambient Air Quality Standards

Pollutant	National		Washington State	PS Clean Air
	Primary	Secondary		
Carbon Monoxide				
8-Hour Average	9 ppmV	None	9 ppmV	9 ppmV
1-Hour Average	35 ppmV	None	35 ppmV	35 ppmV
Sulfur Dioxide				
Annual Average	0.03 ppmV	None	0.02 ppmV	0.02 ppmV
24-Hour Average	0.14 ppmV	None	0.10 ppmV	0.10 ppmV
3-Hour Average	None	0.50 ppmV		
1-Hour Average	None	None	0.40 ppmV	$0.25^b/0.40^c$ ppmV
Lead				
Quarterly Average	$1.5\ \mu g/m^c$	$1.5\ \mu g/m^c$	None	$1.5\ \mu g/m^c$

TABLE 1
National and State Ambient Air Quality Standards

Pollutant	National Primary	National Secondary	Washington State	PS Clean Air
Ozone				
1-Hour Average	0.12 ppmV	0.12 ppmV	0.12 ppmV	0.12 ppmV
8-Hour Average[a]	0.08 ppmV	0.08 ppmV	None	None
Particulate Matter (PM_{10})				
Annual Arithmetic Average	50 µg/m[c]	50 µg/m[c]	50 µg/m[c]	50 µg/m[c]
24-Hour Average	150 µg/m[c]	150 µg/m[c]	150 µg/m[c]	150 µg/m[c]
Particulate Matter ($PM_{2.5}$)				
Annual Arithmetic Average	15 µg/m[c]	15 µg/m[c]	None	None
24-Hour Average	65 µg/m[c]	65 µg/m[c]	None	None
Particulate Matter (TSP)				
Annual Geometric Average	None	None	60 µg/m[c]	None
24-Hour Average	None	None	150 µg/m[c]	None
Nitrogen Dioxide (NO_2)				
Annual Average	0.053 ppmV	0.053 ppmV	0.05 ppmV	0.053 ppmV

[a] The ozone 8-hour standards are included for information only. A 1999 federal court ruling blocked implementation of these standards, which EPA proposed in 1997. EPA has asked the U.S. Supreme Court to reconsider that decision.

[b] Not to be exceeded more than twice in 7 consecutive days.

[c] Never to be exceeded.

ppmV = parts per million by volume
$\mu g/m^3$ = microgram per cubic meter

Sources:

Puget Sound Clean Air Agency Regulation 1, Article 11: Ambient Air Quality Standards. April 14, 1994.

Washington State Department of Ecology Air Quality Program, 2000-2002 Air Quality Trends Report.

Geographic areas in which the NAAQS for all criteria pollutants are met are called “attainment areas.” Areas in which one or more standards are exceeded are called “nonattainment areas.” A nonattainment area must develop and implement a plan to meet and maintain NAAQS. Once EPA approves the plan, it becomes a federally enforceable State Implementation Plan (SIP) for air quality. When a nonattaining region again meets the standard, the area can be redesignated as a “maintenance area.” A maintenance area is a geographic region redesignated by EPA from nonattainment to attainment as a result of monitored attainment of the standard and EPA approval of a plan to maintain air quality standards for at least a 10-year period.

In the past, King and Snohomish Counties were “nonattainment areas” for carbon monoxide and ozone. EPA redesignated the region as a “maintenance area” on October 10, 1996, for carbon monoxide and on November 26, 1996, for ground-level ozone. Before that, much of the area was nonattainment for PM and lead, but the area has also met the national air quality standards for these pollutants and has been redesignated as an attainment area for those pollutants. The project, therefore, would be located in areas that are currently designated "maintenance areas" for PM, lead, CO, and ozone. In short, the air quality in the area is good, and the focus of air quality regulatory efforts is to ensure that it remains the same for the future. The area that the proposed project is in meets the NAAQS for the other criteria pollutants and therefore is designated "attainment" for those pollutants.

2.2.2 Hazardous Air Pollutants

In addition to the criteria pollutants regulated by the NAAQS, there is another set of federally regulated air pollutants known as hazardous air pollutants, or HAPs. HAPs are a set of 188 chemicals specifically regulated by EPA that are known or believed to cause human health effects. A list of HAPs is included in Attachment A.

New air emission sources must comply with all federally established New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP), where applicable, for the type and size of source proposed. Most NESHAPs only apply to "Major" sources of HAPs. A source would be designated a Major Source of HAP if it emits or has the potential to emit more than 10 tons per year of any individual HAP and/or 25 tons per year of all HAPs combined. Sources that are Major for HAPs may trigger a NESHAP, and if so are required to install MACT. A MACT standard that applies to wastewater treatment plants that are Major Sources of HAPs is 40 Code of Federal Regulations (CFR) Part 63, subpart VVV, National Emission Standards of Hazardous Air Pollutants: Publicly Owned Treatment Works. If turbines or reciprocating engines are selected in the final design of the treatment plant, the combustion technology used would need to comply with the new MACT standard, if applicable. Again, it is not expected that the plant would be a major HAP source, even with any selected combustion technology, but final determination would occur with the NOC application for the plant.

2.2.3 Toxic Air Pollutants

New emission sources must also comply with all state and local emission standards. Chapter 173-460 Washington Administrative Code (WAC) and Puget Sound Clean Air Regulation III regulate controls for new sources of toxic air pollutants (TAPs), which are also called air toxics. TAPs are a specific set of more than 600 chemicals listed in WAC 173-460-150. The list of TAPs is included in Attachment B. All of the 188 federal HAPs are included in the Washington State list of TAPs. The codes establish the systematic control of new sources emitting TAPs to maintain air quality levels that would protect human health and safety. Most of the listed TAPs have been assigned an acceptable source impact level (ASIL). ASILs are used to assess the impact of a single-source TAP emission on the ambient air. An Acceptable Source Impact Analysis is a procedure that compares maximum incremental ambient air impacts from a single source with ASILs. The permit requirements for new sources of TAPs require that the source install best available control technology for toxics (TBACT), and that the resulting emissions be shown (by air dispersion modeling) to be below the ASILs[1] outside the plant. An applicant can demonstrate that TAP emissions are below the ASIL by air dispersion modeling or showing that the emission rates are below the small quantity emission rate

[1] More detailed analysis is required for sources that apply TBACT and still exceed the ASIL.

(SQER) identified in WAC 173-460-080 (e). If the expected emissions from a source are below an SQER, no further air quality impact analysis is required in most cases. If the emissions are above the SQER, ambient air quality modeling is required. However, in all cases the TBACT must be installed. If the predicted ambient air impact of a compound exceeds its assigned ASIL, an optional procedure can be used to show compliance with WAC 173-460, called a second-tier analysis. The second-tier analysis uses a health impact assessment instead of an ASIL.

There are two classes of TAPs, Class A and Class B, representing carcinogens (or suspected carcinogens) and noncarcinogens, respectively. Most of the listed TAPs have been assigned an ASIL. ASILs are maximum ambient air concentrations in micrograms per cubic meter ($\mu g/m^3$) that are used to assess the impact of single-source TAP emissions on the ambient air. Each class has a different averaging time for the ASIL. Impacts from Class A TAPs are usually assessed on an annual average. Impacts from Class B TAPs, which are noncarcinogens, are usually averaged over a 24-hour average. Lead is one of those exceptions. Lead is a Class A toxic, but its impact is assessed on a 24-hour basis. For the Brightwater Treatment Plant, dispersion modeling was used to develop concentrations of TAPs at offsite receptors for the two locations. The concentrations are compared to the ASILs. This is further discussed in Section 5.0, Air Quality Impacts Assessment.

2.2.4 Odor

While the Clean Air Act and state and local regulations set numerical standards for criteria pollutants, HAPs, and TAPs, they do not set numerical standards for odors. PS Clean Air regulates odors in the Puget Sound area and enforces local and state law. Puget Sound Clean Air Regulation I, Article 9.11(a), Chapter 70.94 RCW and WAC 173-400-040 (4) and (5) address odors and emissions that may be a detriment to a person or property. Puget Sound Clean Air Regulation I, Article 9.11(a) says that:

> It shall be unlawful for any person to cause or allow the emission of any air contaminant in sufficient quantities and of such characteristics and duration as is, or is likely to be, injurious to human health, plant or animal life, or property, or which unreasonably interferes with enjoyment of life and property.

PS Clean Air may take enforcement action under this regulation upon the proper documentation and identification of the source of odor.

2.3 Air Quality Permitting Requirements

In the state of Washington, all new sources must go through new source review (NSR) with the permitting authority, in this case PS Clean Air, unless specifically exempt according to Puget Sound Clean Air Regulation I, Section 6.03. The NSR process requires the source to submit a “Notice of Construction and Application for Approval,” commonly referred to as a Notice of Construction (NOC) application. As part of the NOC application process, new emission sources must apply BACT, as defined by PS Clean Air, to minimize emissions and comply with all state and local emission standards.

In addition, for sources with potential emissions of more than 250 tons of a criteria pollutant per year[2], a Prevention of Significant Deterioration (PSD) permit is required. Wastewater treatment plants typically emit less than 250 tons of criteria pollutants, and the Brightwater Treatment Plant's emissions would be well below this level; therefore, a PSD permit would not be expected for Brightwater Treatment Plant. For the PSD permit process, (i.e., for emission sources that emit greater than 250 tons/year of criteria pollutants), sources must propose BACT, as defined by EPA, to minimize emissions. The Brightwater Treatment Plant triggers NSR, but not PSD.

In addition to state permitting requirements, a treatment plant may also be required to obtain a Federal Operating Permit under the Clean Air Act's Title V Air Operating Permit Standards. Title V of the Clean Air Act requires states to adopt an EPA-approved air operating permit program for major sources. A major source for Title V purposes is defined as a source with an annual potential to emit more than 100 tons per year of any pollutant regulated under the federal Clean Air Act, or more than 10 tons per year of any one HAP, or 25 tons per year of total HAPs. Sources with emissions of less than 100 tons per year of all pollutants regulated under the federal Clean Air Act, less than 10 tons per year of each HAP, and less than 25 tons per year of total HAPs, are considered to be minor sources for Title V. Within the project area, EPA has delegated authority to issue air quality operating permits to PS Clean Air. PS Clean Air is responsible for issuing Air Operating Permits and NOCs for new or modified sources of air pollution within King, Kitsap, Pierce, and Snohomish Counties. However, for major new or modified sources emitting greater than 250 tons/year, Ecology is responsible for issuing the PSD permit.

2.3.1 Best Available Control Technology

New air pollution sources in Washington State must control emissions of criteria pollutants to the BACT level and toxic air pollutants to the TBACT level. Emissions from the Brightwater Treatment Plant would include six criteria pollutants: nitrogen oxide (NOx), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter less than 10 microns in diameter (PM_{10}) and less than 2.5 microns in diameter (PM2.5), lead and volatile organic compounds (VOCs), and several toxic air pollutants and odorous compounds. During the air quality permitting process, a BACT analysis would be conducted for each of the criteria pollutants, regulated substances, and odor emissions. Typically the toxic air pollutants are either VOCs or particulates. The BACT and TBACT analyses follow the same general approach and often result in the same outcome. A BACT analysis typically includes five steps, called the "top-down" BACT approach. The five steps are:

1. Identify all potential control technologies.
2. Eliminate technically unfeasible options.
3. Rank effectiveness of control technologies.
4. Evaluate cost effectiveness of control technologies.
5. Select BACT.

The top-down approach provides that all available control technologies be ranked in a descending order of control effectiveness. To be "available," a technology must be demonstrated to be effective in a commercial application under comparable operating

[2] EPA has established a 100 ton per year threshold for some classifications. However, pulicly owned treatment works (POTWs) are not one of those classes.

conditions. After available technologies are compiled and ranked, the technologies must be evaluated for technical feasibility, starting with the most effective technology. A control technology can be considered unfeasible because of technical considerations, energy requirements, environmental impacts, or economic impacts. If the most effective technology is eliminated in this fashion, then the next most effective alternative is evaluated using these same criteria. The process is repeated until either a technology is selected or there are no remaining technologies to consider.

Because BACT is an evaluation of control technologies, and because technologies are continuously being improved or new technologies introduced, the technology selected as BACT would change over time. Because it could be many years from the time of the Final EIS to the start of construction, BACT determinations are made during the NOC application process. King County recently submitted an NOC application for two co-generation turbines at the King County South Wastewater Treatment Plant (Kennedy/Jenks Consultants, 2003). For this Final EIS, the control technologies used to estimate emissions from the co-generation facility at the Brightwater Treatment Plant are based on the selection made for the South Treatment Plant in the NOC application. A BACT analysis for the Brightwater Treatment Plant would be conducted when an NOC application is submitted for the treatment plant; however, it is unlikely that the BACT analysis at that time would result in increased emissions.

For major sources of HAP emissions, EPA has developed MACT standards for publicly owned treatment works (POTWs) and is in the process of developing new MACT standards for turbines and reciprocating engines at major HAP sources. The MACT for POTWs is applicable only to facilities that are a major source of HAP emissions. The Brightwater Treatment Plant, as currently shown in the conceptual designs, is not a major source of HAP emissions. If turbines or reciprocating engines are used in the final design of the treatment plant, the combustion technology used would need to comply with the new MACT standard, if applicable. Again, it is not assumed that the plant would be a major HAP source, even with any selected combustion technology, but final determination would occur with the NOC for the plant.

2.3.2 Federal Programs

The EPA has a list of regulated substances (see Attachment C) subject to the requirements for Chemical Accident Prevention Provisions, Risk Management Planning (40 CFR 68). The Risk Management Plan (RMP) chemicals are toxic and flammable chemicals that EPA has determined pose a threat when they are present above certain threshold quantities. While the Brightwater Treatment Plant is expected to use sodium hypochlorite, sodium hydroxide, sulfuric acid, and ferric chloride for its various odor prevention and wastewater treatment processes, none of these chemicals are included on the EPA's list of regulated substances in 40 CFR 68. Because none of the regulated chemicals would be present at the plant, the plant would not need an RMP.

A list of types and quantities of chemicals used onsite at the Brightwater Treatment Plant would be required under the Federal Emergency Planning and Community Right-To-Know Act (as implemented in 40 CFR 372, 40 CFR 355, and 40 CFR 370). Submittal of a Form R may be required annually by 40 CFR 372 for specific toxic chemicals. Sulfuric acid, which could be used in the multistage odor scrubbers, could potentially be used at the treatment plant in quantities that exceed the Form R annual use quantity threshold for reporting. The plant would likely be subject to the annual reporting requirements of 40 CFR 355 because the amount of sulfuric acid stored at the plant would be above the 40 CFR 355 storage threshold quantity of 1,000 pounds. The plant would need to submit initial material safety data sheet (MSDS) information and annual Tier II forms for a number of different chemicals, as required by 40 CFR 370; the Tier II form information is required annually for chemicals stored above the 40 CFR 370 threshold quantities (for most chemicals this is 10,000 pounds). These submittals would be sent to the Washington State Emergency Response Commission, the Local Emergency Planning Committee, and the local fire department. If the chemicals used at the plant differ in type or quantity from those currently proposed, the applicability of these regulations would need to be reevaluated. Further information on chemical storage and handling can be found in Chapter 9, Environmental Health.

2.4 Project-Specific Regulatory Requirements

To fulfill the air quality requirements for the Brightwater Treatment Plant, the following actions may be required:

- File NOC application and receive an Order of Approval permit under Section 6.07 of Puget Sound Clean Air Regulation I, Article 6: New Source Review.
- Apply for and receive an Air Operating Permit in compliance with the Washington Clean Air Act, Chapter 70.94 RCW, Chapter 173-401 of the WAC, and Puget Sound Clean Air Regulation I, Article 7.

Based on the currently assumed design parameters, the treatment plant would be required to have an NOC, but would not be required to have a Federal Title V operating permit because it would likely emit less than 100 tons per year of any criteria pollutant, less than 10 tons per year of any single HAP, or less than 25 tons per year of any combination of HAPs. As part of the NOC application process, new emission sources must also comply with all state and local emission standards. New emission sources of criteria pollutants must apply BACT and new emission sources of toxic air pollutants must apply TBACT, as defined by PS Clean Air. Because the treatment plant would not be expected to be a major source of HAPs, federal MACT standards should not be applicable to this treatment plant unless turbines or reciprocating engines are used in final plant design.

An annual emission inventory submitted to PS Clean Air would be required for the treatment plant. The emission inventory would report the annual emissions of criteria pollutants or air contaminants, which include NOx, CO, VOCs, SOx, and PM. The treatment plant would also be required to report emissions of TAPs and HAPs. Currently, facilities are not required to report emissions of the greenhouse gases carbon dioxide and methane, but this may change in the next few years if the regulatory agencies adopt specific standards, regulations, or reporting requirements focused on greenhouse gases.

3 ELEMENTS COMMON TO ODOR AND AIR QUALITY ANALYSES

3.1 Introduction

This section provides an overview of the project elements and tools that are common to both the odor and air quality impact analyses. The discussion includes, in order: a review of the treatment plant processes that contribute air emissions, identification of the types of models used, and a description of the scenarios modeled.

3.2 Treatment Plant Overview

The treatment plant proposed for either the Route 9 or Unocal site has most of the same major process units that contribute air emissions. These include:

- Influent pump station
- Headworks (screening and degritting)
- Primary sedimentation basins
- Ballasted sedimentation basins
- Aeration basins
- Membrane tanks
- Disinfection for Puget Sound discharge (Unocal only. At Route 9, disinfection occurs in the effluent tunnel.)
- Disinfection for reuse
- Diesel-fired standby internal combustion engine generators
- Co-generation turbines (digester gas and natural gas)
- Enclosed flare (digester gas)
- Hot water boilers (natural gas)

3.3 Mass Emission and Dispersion Modeling

Two models were used in the air quality impacts analysis: a model to develop mass emissions, and a model to simulate offsite impacts from the treatment plant emissions.

3.3.1 Mass Emission Modeling

Because Brightwater is a new treatment plant, direct source testing of its process units is not feasible. Mass emissions of air toxics from the treatment plant's liquid processes were predicted using the Bay Area Sewage Toxics Emission (BASTE) model. BASTE is a fate model specifically designed for use by publicly owned treatment works (POTWs) to estimate emissions from liquid wastewater treatment processes due to volatilization, sorption, and biodegradation. BASTE is one of several air emissions models that can be used. It is POTW-specific, has been validated on numerous POTW applications since it was developed in 1989, and is one of four models (others are ToxChem, Water9, and Water7) currently accepted by EPA for estimating air emissions from POTWs. Input requirements for BASTE are generally more extensive than other general fate models, but the effort put into model preprocessing and information preparation significantly increases flexibility and accuracy of emission estimates from any wastewater treatment process, including the ones proposed for the Brightwater Treatment Plant. A comparison of the three models (BASTE, Water7 [an earlier version of Water9] and ToxChem) was done by Tata[3] and showed that of the three models available, BASTE yielded the smallest difference between the predicted emission rates and directly measured emissions.

The detailed input requirements of BASTE allow the model to be highly plant-specific and to analyze any complex treatment configuration. Important properties that affect the fate of toxic chemicals in wastewater include liquid and gas phase diffusivity, Henry's

[3] Tata, Prakasam, et al. *Prediction of Volatile Organic Compound Emissions from Publicly Owned Treatment Works*.

law constant, octanol-water partition coefficient, covered processes, ventilation air, and biodegradation rate constant. Diffusivities and the Henry's law constant are important for defining the extent of volatilization, and the octanol-water partition coefficient has been observed to correlate with sorption to solids particles and biomass. Emission rates vary if the process is covered or uncovered and are impacted by any covered processes' ventilation air flow rates.

In a wastewater treatment plant, gas-liquid partitioning can occur at the surface of channels, to/from bubbles used in processes with aeration, and over weirs and drops. For each type of system, the variables that affect gas-liquid partitioning can be quite different. The mass flux is usually modeled using a concentration "driving-force" of the form:

$$F = K_o\left(C_1 - C_g / H\right)$$

where F is the flux with units of mass per time per unit area, C_1 is the concentration in the bulk liquid with units of mass per volume, C_g is the concentration in the bulk gas with units of mass per volume, H is the dimensionless Henry's Law constant, and K_o is an overall transfer or partition constant with units of length per time.

The BASTE model accounts for ventilation in the headspace above a covered liquid process. As air flow rates increase, the concentration in the exhaust air stream decreases, but the mass emissions could increase because the flux rate from the surface could increase. BASTE does not predict equilibrium concentrations by mass flux rates based on the input conditions.

The influent HAP compound list and concentrations in BASTE are provided in Attachment D. These concentrations are default values based on Association of Metropolitan Sewage Agencies (AMSA) 1993 National Influent Survey, which obtained influent toxic concentration data from 181 POTWs. Default values from AMSA are an acceptable data source when no actual influent data are available. The influent concentrations and mass loading for the King County South Wastewater Treatment Plant were reviewed, but the total mass loading of the AMSA values was more conservative and the AMSA values therefore were used.

The BASTE model output is shown as a mass emission rate in pounds per year (lb/yr) (see Section 5, Air Quality Impacts Assessment). The mass emission rate is divided by the process ventilation rate in cubic feet per minute (cfm) and converted to a concentration (kg/m^3). The ideal gas law, assuming an air temperature of 21°C and one atmosphere pressure, is used to convert the value to a part per million by volume concentration (ppmV). The mass emission rates are listed in Section 5, Air Quality Impacts Assessment.

3.3.2 Dispersion Modeling

Air dispersion models are used routinely to estimate air quality and odor impacts from emissions released by point (such as stacks), area (such as water holding basins), and volume (such as open truck-loading areas) sources. These types of sources generally characterize the majority of sources that would emit odors and air toxics at a wastewater treatment plant. Air dispersion modeling is the generally accepted, and EPA approved, tool used to predict offsite impacts.

EPA's Industrial Source Complex Short-Term Dispersion Model (ISCST3, version 02035) was used in the air dispersion modeling analysis to evaluate offsite impacts. The ISCST3 model is recommended by EPA for use in demonstrating compliance with the NAAQS. The ISCST3 model uses local hourly meteorological data to define the local dispersion environment and accepts a receptor array that contains topographic data from the U.S. Geological Survey (USGS). It is also capable of modeling point, area, and volume sources. The ISCST3 is widely used in odor and air quality impact assessments. ISCST3 is a straight line Gaussian plume model that uses mathematically and statistically averaged approximations of plume rise and downwind dispersion behavior to estimate downwind impacts. The model calculates the impacts from the treatment plant's emissions at multiple locations (receptors) around the treatment plant beyond the plant's property line.

Two other models are typically used for air dispersion modeling, AERMOD and CALPUFF. AERMOD is also a Gaussian plume model. The dispersion coefficients are based on boundary layer theory rather than empirically derived from sampling data. The model has been validated by data sets with sampling data averaged over a 1-hour time period. Although proposed by EPA as a replacement for ISCST3, it has not been formally accepted as such.

EPA does not recommend a model for odor dispersion modeling. EPA provides no guidance on how odor dispersion modeling studies are to be performed. If EPA adopts AERMOD as the preferred model, it does not mean that AERMOD must be used for odor modeling or that ISCST cannot be used.

The acceptance of AERMOD by EPA is specific to air quality demonstrations for pollutants with NAAQS. EPA does not have a consistent policy on modeling air toxics. Many air quality modeling studies for air toxics are driven by state rather that federal regulations. Thus, it would be up to the state or local permitting authority to approve a particular model for air toxics modeling.

CALPUFF is a Lagrangian puff model. A recent Federal Register notice formally endorsed CALPUFF as the preferred model for long-range transport studies and would grant approval on a case-by-case basis for studies where complex wind flows are a factor in modeling impacts. The model can be used for short transport times as well. The meteorological data needed to run the model can be a single meteorological station (as would be the case for ISCST3) or developed from several stations (as would be required for long-range transport studies). Use of the CALPUFF model for odor studies has been limited.

A comparison of the ISCST3, AERMOD, and CALPUFF models for odors was conducted by Diosey[4]. This comparison showed that maximum predicted impacts from a typical wastewater treatment plant were similar for ISCST3 and CALPUFF run in the refined mode. Predicted impacts for AERMOD were a factor of 24 lower than ISCST3 and a factor of 2 lower than CALPUFF run in the screening model.

[4] Diosey, Phyllis G., Maureen E. Hess, and Larraine Farrell. 2002. Evaluation of Alternative Dispersion Models for Use in Odor Management. *WEFTEC 2002 75th Annual Technical Exhibition and Conference, Conference Proceedings*. Water Environment Federation, Alexandria, VA.

The ISCST3 air dispersion model computes a concentration impact for each pollutant for every hour of every day at each individual receptor point. The emissions from the plant are dispersed in the direction the wind is blowing for each hour of meteorological data that are input into the model. Therefore, the impacts at each receptor are the result of the direction of the wind, the speed of the wind, the air temperature, the amount of sunlight, and the atmospheric stability (the ability of the atmosphere to disperse pollutants by mixing the air both vertically and horizontally). Stability is affected by temperature, sunlight, and wind speed. In general, the lower the wind speed, the less air is able to mix and dilute emissions. Temperature also affects stability. When temperature does not change much from one hour to another, the atmosphere is also less able to mix and dilute pollutants. Sunlight also affects stability. The more sunlight, the better the atmosphere mixes vertically, resulting in better dispersion. The impacts at each receptor are also a function of exhaust parameters such as exhaust height, temperature and stack exit velocity. Emissions that are from tall stacks and at high temperature and high velocity generally get more diluted than emissions from low, cool stacks with a low exit velocity.

For the Brightwater Treatment Plant, standard EPA-approved methodology and approaches were used that match required analysis and needs for siting a new treatment plant at both targeted locations. These approaches are based on criteria set forth by PS Clean Air and consistent with the EPA's *Guideline on Air Quality Modeling*. This document describes the modeling process so that models are used according to the way they were designed. By following this process, model results would be comparable with each other and with results from other modeling.

Modeling Puff Conditions for Odor Impacts

ISCST3 predicts 1-hour average pollutant concentrations. However, odor nuisances are most often associated with puff conditions, or exposure times, on the order of seconds or minutes rather than hours. Modeling puff conditions is not required or necessary for air toxic (HAP and TAP) risk analyses because risk analyses are based on longer periods of time, such as 24-hour averages or lifetime (70-year) exposures. Puff conditions best mimic potential odor nuisance events. Averaging over an hour has the effect of smoothing out the odor concentration peaks. Therefore, the 1-hour odor concentrations predicted by ISCST3 were converted to peak 3-minute odor concentrations (using the power law) for the odor modeling. The peak 3-minute odor concentrations are several times greater than the 1-hour average odor concentration and better represent puff odor conditions.

Specifically, the 1-hour odor concentrations predicted by ISCST3 were converted to peak 3-minute odor concentrations using the following power law:

$$\chi_s = \chi_{1-hour}\left(\frac{60\,\text{min}}{t_s}\right)^p$$

where χ_s is the short-term odor concentration, $\chi_{1\text{-hour}}$ is the model-predicted 1-hour odor concentration, t_s is the desired short term averaging time (in minutes), and p is the power-law exponent. The value of the p varies by atmospheric stability class. Table 2 shows the peaking factors used to convert from 1-hour to 3-minute concentrations.

Stability is categorized into six stability classes, A through F. Class A (Unstable) represents excellent dispersion characteristics, such as considerable vertical and horizontal air movement, which allows pollutants to disperse easily. It has more large-scale turbulence and promotes mixing through a greater depth of the atmosphere. A looping plume is characteristic of Unstable conditions. Because the concentration in a puff from the source can be much greater than the time average distribution through the mixing layer, the peaking factor is greater for Unstable conditions than for more stable conditions.

TABLE 2
Three-Minute Peaking Factors

Stability Class	Power-Law Exponent (*p*)	3-Minute Peaking Factor[a]
A, B	0.5	4.47
C	0.33	2.71
D	0.2	1.82
E, F	0.167	1.65

[a] For example, under a stability category A, the peak 3-minute concentration would be 4.47 times greater than the 1-hour average concentration.

Source: Wang, Jie, and Kenneth J. Skipka. *Dispersion Modeling of Odorous Emissions.* RTP Environmental Associates. June 13, 1993.

Class F (Very Stable) represents very poor air movement. Very Stable air is defined as having low wind speed, little change in wind direction, overcast conditions, and temperature inversions. The scale of turbulence is smaller and the depth of the mixing layer is often limited by temperature inversions. Coning or fanning plumes are typical of more stable conditions. Class F conditions result in higher concentrations of air pollutants. Because puffs from a source do not meander through as great a mixing layer, the difference between the concentration in a puff and the time-averaged distribution is smaller and the peaking factor is smaller for Very Stable conditions.

A common mistake in odor studies is to apply the "most conservative" Peaking Factor of 4.47 to the highest predicted concentration, which often occurs during stable conditions. This results in a "peak" concentration that may be three times greater than the concentration that would be obtained if the correct approach, as described in Table 2, were used. During stable conditions, the peak and average conditions show minimal variation and, therefore, the peaking factor is smaller.

Air and Odor Model Dispersion Coefficients

The Pasquill-Gifford dispersion coefficients used in the ISCST3 model for both odor and air toxics are based on ambient sampling data collected as part of various studies done by EPA. For many of these studies, the emission source was a ground-level release of a neutrally buoyant gas. The samples were collected along arcs located 100 meters to several kilometers downwind. The sample time ranges from 6 to 15 minutes. The types of emission sources found at a wastewater treatment plant are often ground-level releases or relatively short stacks that emit a nearly neutrally buoyant gas. Transport times for odor studies are relatively short, often to the nearest plant property boundary.

ISCST3 was run with the following options, as recommended in EPA's *Guidelines on Air Quality Modeling*:

- Regulatory default options
- Direction-specific building downwash

- Actual receptor elevations
- Complex/intermediate terrain algorithms

ISCST3 allows the selection of either rural or urban dispersion coefficients. The Auer land-use classification was used to determine the dispersion model for this analysis. Under the Auer scheme, if more than 50 percent of the land area within 3 kilometers of the treatment plant has an urban land use classification, the urban dispersion coefficients should be used. The urban lands are industrial, commercial, and compact residential areas that have limited areas of vegetation due to the presence of buildings or paving. All other land use types, including common single-family residential areas, undeveloped areas, and agricultural areas, would be considered rural.

Rural dispersion coefficients were used for both the Route 9 and Unocal sites. More than 50 percent of the land use within 3 kilometers of the Route 9 site would be forested and single-family residential areas. The Unocal site has water on one side and not many buildings or parking lots. Neither site is considered urban for the purpose of dispersion modeling.

Receptor Grid

The dispersion model calculates the impacts from the treatment plant emissions at multiple locations around the treatment plant. The locations where the impacts are calculated are called receptors. The grid spacing for receptor points is determined by guidelines for setting up models according to the EPA document *Guidelines on Air Quality Modeling*. This document describes the modeling process so that models are used according to the way they were designed. By following this process, model results are consistent and comparable.

Several sets of receptors were used to obtain the location and magnitude of the maximum offsite concentrations at each treatment plant site. Receptors were located along the site fence line (which is inside the property line) and beyond for the air toxics modeling. For the odor modeling, receptors were located at the property line and beyond. A coarse grid was centered on each site with a 1,640-foot (500-meter) spacing between receptors. This grid extended approximately 5 miles around the site. For the air quality modeling, a 328-foot (100-meter) spaced grid centered on the treatment plant extended 3,280 feet (1,000 meters) from the treatment plant fence line. Fence line receptors were placed at 164-foot (50-meter) intervals around the treatment plant.

In addition to the receptor configuration described above, a receptor grid was added to the Unocal Structural Lid sub-alternative analysis to consider areas where the public could have access. This receptor grid had 82-foot (2-meter) spacing between receptors over the entire area of the multimodal lid.

Determining sensitive receptors is part of the process that King County is required to follow in order to show compliance with federal, state, and local air pollution regulations. As part of this process, an NOC Permit Application would be prepared for submittal and would have to be approved by PS Clean Air before construction could begin.

Sensitive receptors are identified to acknowledge the presence of people within a 5-mile radius of the treatment plant site who may experience compromised respiratory systems. People with compromised respiratory systems may be more sensitive to air pollutants that may or may not be odorous. The term "sensitive receptor" is not meant to be applied to those who are more likely to detect an odor. Additional receptors were added to the model at the locations in Table 3 to ensure that concentrations were calculated at "sensitive receptors" such as schools, parks, hospitals, retirement homes, and senior citizen and daycare centers. The model grid included multiple receptors in the vicinity of the ferry terminal and on the lid of the multimodal facility.

Areas that were not specifically for seniors or children, such as apartment buildings, or locations were sensitive individuals would typically not spend a significant amount of time each year, such as recreational areas, were not included in the list of added sensitive receptors.

Table 3 shows the sensitive receptors that were added to the model's receptor grid. The locations of the sensitive receptors were identified using GIS data files provided by King County and Snohomish County. This table may not be a complete listing of sensitive receptor locations; however, with model receptors located every 100 meters, there is a receptor near all potential sensitive receptor locations within 1,000 meters of the plant. If the concentrations at specific receptor points are below the ASIL, then the areas between the receptor points are also below the ASIL.

TABLE 3
Added Receptor Points for Sensitive Receptor Locations

Sensitive Receptors Within 5-Mile Radius of the Route 9 Site		Sensitive Receptors Within 5-Mile Radius of the Unocal Site	
Bear Creek Elementary	Kokanee Elementary School	Albert Einstein Middle School	Lynnwood Intermediate School
Bellevue Christian-Woodinville	Leota Junior High School	Aldercrest Convalescent Center	Madrona Middle School
Bothell High School	Maltby Elementary School	Aldercrest Learning Center	Meadowdale Elementary School
Canyon Creek Elementary School	Maywood Elementary	Aurora-Edmonds Nursing Home	Meadowdale High School
Canyon Park Junior High School	Montessori House School	Beverly Elementary School	Meadowdale Middle School
Cathcart Elementary School	Northshore Junior High School	Cedar Valley Elementary School	Meridian View Elementary
Cedar Park Christian	Ricketts Building	Cedar Way Elementary School	Mountlake Terrace Elementary School
Cedarwood Elementary School	Robert Frost Elementary	Cedarbrook Elementary	Mountlake Terrace Senior High School
Chrysalis School	Secondary Alternative School	Chase Lake Elementary School	North City Elementary
Cottage Lake Elementary	Shelton View Elementary School	College Place Elementary School	Parkwood Elementary
Eastern Star Nursing Home	Skyview Middle School	College Place Middle School	Planned Parenthood
Crystal Springs Elementary School	Sorenson Early Childhood Center	Echo Lake Elementary	Scriber Lake High School

TABLE 3
Added Receptor Points for Sensitive Receptor Locations

Sensitive Receptors Within 5-Mile Radius of the Route 9 Site		Sensitive Receptors Within 5-Mile Radius of the Unocal Site	
Evergreen Academy	St. Brendan School	Edmonds Community College	Seaview Heights Elementary School
Fernwood Elementary School	Sunrise Elementary	Edmonds Elementary School	Sherwood Elementary School
Frank Love Elementary School	Support Services Building	Edmonds Landing Retirement Community	Shoreline Children's Center
Gateway Middle School	Timbercrest Elementary	Edmonds Rehabilitation/Health Care	Shoreline Community College
Heritage Christian School	Timbercrest Junior High School	Edmonds School District #15	Shorewood Senior High School
Hillcrest Building	Wellington Elementary	Edmonds/Woodway High School	Snohomish County Christian School
Hilltop Elementary School	Westhill Elementary	Educational Service Center	South County Senior Center
Hollywood Hill Elementary	Woodin Elementary	Evergreen Elementary School	St. Luke School
John Muir Elementary	Woodinville High School	Highland Terrace Elementary	St. Mark School
Heritage Christian School	Woodinville Montessori School	King's Elementary/High School	Stevens Memorial Hospital
Kamiakin Junior High School	Woodmoor Elementary	Lake Forest Park Elementary	Sunset Middle School
		Lake Forest Park Montessori	Syre Elementary
		Lynndale Elementary School	Terrace Park Elementary School
		Woodway Elementary	The Highlands School

Meteorological Data

Typically, air dispersion modeling is performed during the permitting phase. Meteorological data from the nearest offsite meteorological station are used because onsite meteorological data typically are not available. This is a routine procedure and is accepted by Ecology. Any available onsite data would be used.

For the Brightwater System Final EIS, air dispersion modeling was performed. The meteorological data used in the air dispersion modeling analysis were above and beyond the commonly used offsite data from the nearest meteorological station. Meteorological stations were installed at both the Route 9 and Unocal sites in July 2002 to gather site-specific data. Nine months of data (July 2002 through March 2003) were gathered prior to the preparation of this Technical Appendix (1 year of data were not yet available when the modeling was performed). In addition, 4 years of meteorological data from Paine Field were analyzed. Two separate model runs were conducted for each site, one using the site-specific data and one using the Paine Field data. By using both data sets, the worst-case data from both meteorological station were modeled. Again, this is more analysis than is typically performed for an EIS.

By using both the site data and Paine Field data, the model predicted worst-case maximum impacts for any single hour of meteorological data from the combined data set. The Paine Field data had a greater frequency of Very Stable, or worst-case, conditions than the site-specific data. All meteorological data from Paine Field and the site-specific stations were modeled, including worst-case meteorological conditions. The model would typically overpredict worst-case impacts, so by using the Paine Field data (which has more worst-case days) with the site-specific data, an extra degree of conservatism was incorporated into the modeling.

Wind roses for the three meteorological stations are shown in Figures 1 through 3. A wind rose is a graphical representation of wind speed and direction over a discrete period of time. It is a 360-degree compass that looks like a flower with petals that represent the direction from which the wind is blowing. The four main wind directions—north, south, east and west—are labeled on each figure. The wind speed is expressed numerically on each of the concentric rings of the rose. The length of each petal segment indicates the percentage of wind speed observations that fall into a specific speed category, or ring, for each wind direction. The wind speed categories are identified by different colors in the legend at the bottom of the wind rose figure.

Upper Air Station Data

In dispersion modeling, both surface air and upper air data are used. The surface air data used for the Brightwater Treatment Plant modeling were from the meteorological stations as described above. Upper air data are from weather balloons that are released from the ground and travel high into air (thousands of feet) and gather pressure, temperature, relative humidity, wind speed, and wind direction data. There are two upper air stations in the state of Washington, one in Spokane and one on the Olympic Peninsula at Quillayute. The Quillayute data set is the more appropriate data set of the two to use for both the Unocal and Route 9 sites as the climate is more similar to that in Western Washington and was used in the dispersion modeling.

Paine Field

For the Draft EIS, meteorological data used for the dispersion modeling consisted of surface data collected at the Paine Field Airport station in Everett, Washington. Four years of data (1961, 1962, 1964, and 1965) were used in the model. These were the most complete data sets available from Paine Field. In 1966 Paine Field followed the trend of other small airports in the area and started collecting data for only 18 hours of every day. The airport ceased collecting data at night, because few airplanes landed on Paine field at night. Since many inversions and stable air conditions occur at night, the data collected at Paine Field since 1966 would not include those data. Therefore, the data from 1961, 1962, 1964, and 1965 provide more stable air conditions for the modeling and produce more conservative results than data from more recent years.

A wind rose of the Paine Field data is presented in Figure 1. The hourly data are shown in Table 4. The frequency of winds speeds less than 0.51 meter per second (mps) is indicated at the bottom of the table, because wind speeds this low are not assigned a wind direction.

TABLE 4
Paine Field Meteorological Station (January 1961 – December 1965)

	Wind Speed (mps)						
Wind Direction	**0.51 - 1.80**	**1.80 - 3.34**	**3.34 - 5.40**	**5.40 - 8.49**	**8.49 - 11.06**	**>11.06**	**Total Hours**
N	323	947	590	47	4	0	1911
NNE	235	406	98	2	0	0	741
NE	398	647	107	4	0	0	1156
ENE	415	634	230	34	5	1	1319
E	391	777	409	74	1	0	1652
ESE	1052	1865	840	64	0	0	3821
SE	371	969	604	85	1	0	2030
SSE	367	959	825	276	24	0	2451
S	593	1894	2210	1110	173	30	6010
SSW	355	724	917	636	109	27	2768
SW	303	329	91	24	2	0	749
WSW	66	124	40	1	0	0	231
W	97	171	53	1	0	0	322
WNW	175	311	94	28	2	0	610
NW	309	459	191	37	1	0	997
NNW	879	1674	946	115	2	1	3617
Total number of hours	**6,329**	**12,890**	**8,245**	**2,538**	**324**	**59**	**30,385**

Total number of hours in data set: 35,067 hours
Frequency of winds less than 0.51 mps: 13.34 percent
Average Wind Speed : 3.18 mps

mps = meter per second

Site-Specific Meteorological Stations

Site-specific meteorological data are currently being gathered from two monitoring stations, one near the Unocal site at the Edmonds Marina and one on the Route 9 site. Meteorological monitoring stations have been collecting data at the prospective Unocal and Route 9 sites since July 2002. Data from July 1, 2002, through March 31, 2003, are presented here. The monitoring stations collect data to document wind speed, wind direction, air temperature, relative humidity, solar radiation, barometric pressure, and rainfall.

The meteorological monitoring program was designed to characterize each site's unique wind, temperature, and atmospheric stability for use in air quality models to perform air quality impact analyses for the Final EIS. The data were collected according to EPA standards associated with Prevention of Significant Deterioration (PSD) requirements for new major stationary sources of air emissions. Solar radiation, vertical temperature difference measurements, and standard deviation of wind direction (sigma-theta) were used for calculation of atmospheric stability class. The program is described in *Meteorological Monitoring and Quality Assurance Plan - Brightwater Wastewater Treatment Facility Site Assessments* (Brown and Caldwell, 2003).

Aluminum towers 10 meters tall were installed specifically for this monitoring program. Meteorological sensors on the towers were installed to measure wind speed, wind direction, and temperature at 10 meters; calculated temperature difference between 10 and 2 meters (ΔT); relative humidity at 2 meters; solar radiation at 3 meters; and barometric pressure at 1.5 meters. Rain gauges were installed a short distance from the towers.

Route 9 Site

The Route 9 monitoring station is located just east of Route 9 about 0.5 mile north of the intersection of Route 9 and Highway 522, approximately 3 miles northeast of the town of Woodinville, WA. The site lies in a small valley with hills rising several hundred feet within 1,000 feet to the east and south of the tower. This location for the meteorological station was selected because it is within the proposed boundary of the Route 9 treatment plant site. Therefore, the data collected are representative of the site.

Analysis of the Route 9 data collected from July 2002 through March 2003 show that, for the 9-month period, the winds predominantly blow from the north 50 percent of the time and from the south 23 percent of the time. This pattern is consistent during both winter and summer months. The Route 9 onsite meteorological data are presented as a wind rose in Figure 2. The winds at this site generally follow the terrain and flow up and down the SR-9 corridor, mostly following the Little Bear Creek drainage. Nighttime wind patterns are also from the north. The hourly data are shown in Table 5. The frequency of wind speeds less than 0.51 meter per second is indicated at the bottom of the table, because wind speeds this low are not assigned a wind direction.

TABLE 5
Route 9 Site Wind Speed and Direction (onsite data July 2002 – March 2003)

	Wind Speed (mps)						
Wind Direction	**0.51 - 1.80**	**1.80 - 3.34**	**3.34 - 5.40**	**5.40 - 8.49**	**8.49 - 11.06**	**>11.06**	**Total Hours**
N	735	232	33	0	0	0	1000
NNE	1663	132	1	0	0	0	1796
NE	282	21	1	0	0	0	304
ENE	128	8	0	0	0	0	136
E	158	13	0	0	0	0	171
ESE	204	60	0	0	0	0	264
SE	225	33	0	0	0	0	258
SSE	238	76	0	0	0	0	314

TABLE 5
Route 9 Site Wind Speed and Direction (onsite data July 2002 – March 2003)

	Wind Speed (mps)						
Wind Direction	**0.51 - 1.80**	**1.80 - 3.34**	**3.34 - 5.40**	**5.40 - 8.49**	**8.49 - 11.06**	**>11.06**	**Total Hours**
S	207	283	63	0	0	0	553
SSW	171	198	146	13	2	0	530
SW	179	135	21	2	0	0	337
WSW	54	7	2	0	0	0	63
W	26	6	0	0	0	0	32
WNW	20	20	0	0	0	0	40
NW	54	37	0	0	0	0	91
NNW	120	168	7	0	0	0	295
Total number of hours	**4,464**	**1,429**	**274**	**15**	**2**	**0**	**6,184**

Total number of hours in data set: 6,552 hours
Frequency of winds less than 0.51 mps: 5.63 percent
Average Wind Speed : 1.56 mps

mps = meter per second

Unocal Site

The meteorological station for the Unocal site is located on Port of Edmonds property just north of the former Unocal facility. The ground immediately around the tower is sandy soil, with sparse grass coverage adjacent to railroad tracks to the east and an asphalt parking lot about 25 feet to the west. A boat repair yard is situated to the north and Puget Sound lies generally to the west of the site, with the closest point about 600 feet to the northwest. A 160-foot-high bluff above Edwards Point rises starting about 700 feet directly south of the tower.

Analysis of the Unocal data shows that, from July 2002 through March 2003, the winds predominantly blew from the north 25 percent of the time and from the south and southeast 30 percent of the time. These north-prevailing winds are a result of air flowing from Puget Sound toward the site, which is typical for land locations close to water. The south and southeast flow is caused by the elevated terrain to the south of the site and the curve of the shoreline that forms Edwards Point. This terrain is acting to steer wind flow over and around the land, pushing it downslope toward the site. This pattern is particularly present during nighttime hours and measurable rain events. The Unocal onsite meteorological data are presented as a wind rose in Figure 3. The hourly data are shown in Table 6. The frequency of winds speeds less than 0.51 meter per second is indicated at the bottom of the table, because wind speeds this low are not assigned a wind direction.

TABLE 6
Unocal Site Meteorological Station (onsite data July 2002 – March 2003)

	Wind Speed (mps)						
Wind Direction	**0.51 - 1.80**	**1.80 - 3.34**	**3.34 - 5.40**	**5.40 - 8.49**	**8.49 - 11.06**	**>11.06**	**Total Hours**
N	331	233	45	2	0	0	611
NNE	299	311	31	0	0	0	641
NE	189	319	40	0	0	0	548
ENE	139	30	2	0	0	0	171
E	170	10	4	0	0	0	184
ESE	405	54	14	2	0	0	475
SE	624	300	82	5	0	0	1011
SSE	210	354	379	97	0	0	1040
S	137	270	149	16	0	0	572
SSW	123	171	22	1	0	0	317
SW	92	183	27	2	0	0	304
WSW	46	16	0	0	0	0	62
W	35	4	1	0	0	0	40
WNW	28	8	1	0	0	0	37
NW	60	20	22	4	0	0	106
NNW	173	143	35	5	0	0	356
Total number of hours	**3,061**	**2,426**	**854**	**134**	**0**	**0**	**6,475**

Total number of hours in data set: 6,552 hours
Frequency of winds less than 0.51 mps: 1.19 percent
Average Wind Speed : 2.19 mps

mps = meter per second

Summary of Wind Speed Data

The data summaries in Figures 1 through 3 show the number of hours of data that were collected for each wind speed and direction. This is also summarized in Table 7.

The frequency of calms that are calculated for the wind rose figures is based on the EPA definition of a calm, which is less than 0.5 mps. This calm calculation is useful for interpreting the wind rose figure, but is not related to stability or dispersion model input. Low wind speeds do not always result in very stable conditions. It is possible to have a very low wind speed and unstable conditions.

TABLE 7
Summary of Meteorological Data

Site	Average Wind Speed (mps)	Frequency of Winds < 0.51 mps
Paine Field	3.18	13.24%
Route 9	1.56	5.63%
Unocal	2.19	1.19%

mps = meter per second

The total number of hours in the tables is less than the total number of hours in the data set. Hours with wind speeds between 0.4 mps (the minimum the instrument can record) and 0.51 mps are not shown in the table, but were modeled. The total number of hours in the 9-month period less the total number of hours shown is approximately the number of hours with wind speeds between 0.4 and 0.51 mps. A few hours were not included in the data set when the instruments were being calibrated.

Periods with little or no air movement require special consideration in air quality evaluations because they usually result in the highest impacts offsite from a wastewater treatment plant. The parameter used to characterize air movement is atmospheric stability. A value for stability is calculated for each hour of data collected at a meteorological station. As discussed above, atmospheric stability is grouped in Classes A through F. Class A stability indicates good air movement. Class F stability indicates that the air is very stable and little or no air movement is occurring.

Stability is calculated according to the methods described in *Meteorological Monitoring Guidelines for Regulatory Modeling* (EPA, 2000). Stability can be described as the ability of the atmosphere to disperse pollutants. Stability is determined by wind speed, wind direction, sunlight, and air temperature. Each of these parameters has varying effects on how pollutants are dispersed. All of these parameters are used to determine the stability for each hour of the day. This stability calculation is part of the data input into the ISCST3 dispersion model.

Class F stability, an hourly calculation made from the onsite met data, can only occur at night when the two temperature sensors record an inversion condition where the air temperature is warmer aloft (for the Brightwater meteorological station at the 10-meter level), than at the surface (2-meter level). In addition, the wind speed must be less than 2.0 mps. The frequencies of Class F stability conditions calculated from the hourly meteorological data collected from the Route 9 site, Unocal site, and Paine Field were compared and are shown below:

- Paine Field = 36 percent
- Route 9 = 21 percent
- Unocal = 14 percent

Because of the higher frequency of F stability conditions, the Paine Field data would likely predict higher offsite impacts than either the Route 9 or Unocal data.

Topography

The Draft and Final EIS model results are different at the Unocal and Route 9 sites in part because of the difference in terrain at the two locations. Site-specific topography was used in the dispersion model. U.S. Geological Survey Digital Elevation Map (DEM) files with a resolution of 98 feet were used to estimate the terrain elevation for each receptor. The elevations between the 98-foot grids are determined by interpolation to the nearest 0.1 meter, or approximately 4 inches. These files are available to the public on the Web site http://data.geocomm.com/dem/. Concentrations from all sources were evaluated at ground level (that is, no "flagpole" receptors). The USGS data are recommended by regulatory agencies for input to dispersion modeling.

3.4 Scenarios Modeled

Potential emission estimates were calculated for five different scenarios at the two treatment plant sites:

- Route 9 with an initial capacity of 36 million gallons per day (mgd)
- Route 9 with a buildout capacity of 54 mgd
- Unocal with an initial capacity of 36 mgd
- Unocal site with a buildout capacity of 54 mgd
- Unocal site with a buildout capacity of 72 mgd

Ambient air quality and odor impacts resulting from the project were estimated using dispersion modeling for seven different scenarios:

1. Route 9 site with an initial capacity of 36 mgd (odor modeling only)
2. Route 9 site with a buildout capacity of 54 mgd (odor and air quality modeling)
3. Unocal site with an initial capacity of 36 mgd (odor modeling only)
4. Unocal site with a buildout capacity of 54 mgd (odor and air quality modeling)
5. Unocal site with a buildout capacity of 54 mgd and a structural lid over a portion of the treatment plant (odor and air quality modeling)
6. Unocal site with a buildout capacity of 72 mgd (odor and air quality modeling)
7. Unocal site with a buildout capacity of 72 mgd and a structural lid over a portion of the treatment plant (odor and air quality modeling)

A lid with an approximate top elevation of 50 feet above sea level could potentially be constructed over the northern portion of the treatment plant at the Unocal site only. The lid would be used for a multimodal transportation facility. The addition of the lid would not affect emission rates, but would change the fence line of the treatment plant, which affects the area that must be evaluated. Because the public could have access to the lid area, the fence line of the treatment plant would be reduced to the area surrounding the nonlidded portion of the site – namely, the portion located on the highest terrace and closest to the southern property line. Therefore, for the modeling analyses, the southern edge of the proposed lid was considered to be the northern fence line of the plant and any impact in the lid area would be included in the model results.

4 ODOR IMPACTS ASSESSMENT

4.1 Introduction

The odor impacts assessment starts with the approach followed for the Brightwater Treatment Plant, followed by a description of the odor sources at the treatment plant, identification of the targeted odor compounds, and quantification of the offsite odor impacts.

4.2 Odor Prevention and Control Approach

King County is committed to operating the Brightwater Treatment Plant without odors. To this end, stringent design and performance criteria have been established for odor prevention at the treatment plant. Key elements of this program are:

- Odor standard of no detectable odors at the property line. Brightwater Treatment Plant would be a good neighbor by operating 365 days a year, 24 hours a day, with no offsite odors.
- King County is accountable to PS Clean Air, the State of Washington, and Brightwater Treatment Plant's neighbors regarding odors.
- Brightwater Treatment Plant's goals for odor prevention are currently among the most stringent in the United States and include application of BACT. Other highly controlled plants have less stringent goals than Brightwater Treatment Plant and are allowed to exceed their selected criteria up to 100 hours each year.
- The proposed odor prevention system selected would also be the most advanced in the United States:
  - Three-stage chemical scrubbing followed by activated carbon. This multiple-stage system would be designed to specifically treat target compounds. The activated carbon would be used to remove any residual odors from the multiple-stage scrubbers. This is similar to the activated carbon filters used in homes to remove any trace contaminants in drinking water.
  - Space would be reserved in the first stage of the scrubber to potentially add biotowers or other technologies in the future as new technologies are developed and proven.
  - Liquid-phase treatment would be provided in the collection system and at the influent pump station to reduce the formation of odors, further reducing downstream treatment plant odor loading.
  - Odor prevention systems would be designed to handle peak odor emissions.
  - Odor prevention systems would be sized to handle worst-case operating conditions, when combinations of meteorological conditions (such as inversions and stagnant air, which tend to occur in the autumn and winter) coincide with peak odor releases from treatment processes (which tend to occur in the summer). In reality, the two events are not expected to occur at the same time. All dispersion modeling runs include using worst-case air and odor emissions data.

 - The treatment plant would have dual electric feeders to provide a reliable and redundant power supply to the treatment plant. Onsite energy self-generation using digester gas and natural gas as well as standby diesel internal combustion (IC) engines would provide additional backup power.
 - Redundant equipment would be included in the treatment plant design to provide backup in the event of equipment malfunction or breakdown.

- Additional maintenance air scrubbers would be used during any maintenance activity that requires opening the covered process equipment or building to ensure that no foul air would be released into the atmosphere. Instead, odors would be pulled from the opened processes to the odor prevention system until that process is cleaned and declared to be nonodorous.

4.3 Odor Sources

The following facilities at the treatment plant generate process air, which would be treated in the odor prevention system:

- Influent pump station
- Headworks (screening and degritting)
- Primary sedimentation basins
- Ballasted sedimentation basins
- Aeration basins
- Membrane tanks
- Disinfection for Puget Sound discharge (Unocal site only; Route 9 site disinfection occurs in effluent tunnel)
- Disinfection for reuse

Each process and how the odorous air would be collected and treated is described below. A schematic of the treatment plant, its odor-generating sources, and how the odors are captured and treated are shown in Figure 4. Each liquid process would be fully covered. Air would be pulled from under the cover to the odor prevention system, which would create a negative pressure. A negative pressure minimizes the chance for odors to escape. Buildings would be fully enclosed, with process areas inside the buildings also covered or enclosed, and the process air treated in the odor prevention system. The odor prevention system would receive the process air from the various sources and treat it to eliminate the odor in a three-stage chemical scrubber followed by carbon.

4.3.1 Liquids Processes

The liquids processes treat the wastewater to remove the solids and pollutants through primary treatment, secondary treatment, and disinfection. The process air ventilation system for each is described below.

Influent Pump Station Ventilation System

The influent pump station wet well would collect the raw sewage from the conveyance system in a deep tunnel below the treatment plant. A pump station building would be located at the ground surface to pump the wastewater up to the treatment plant. The influent pump station would be designed with a ventilation system that would keep any potential exposed wastewater surface in the wet well or any process opening area under negative pressure to prevent the escape of process air into the ambient air surrounding the station. The air removed from these areas would pass through odor prevention systems to treat the air before it is discharged to the atmosphere.

Under maintenance conditions, the wet well would be uncovered and additional air changes would be provided to enable maintenance work to be performed safely, and to maintain a low concentration of odorous substances in the pump station. Supplementary maintenance air scrubbers would be used for this purpose.

Preliminary Treatment (Headworks) Ventilation System

Both screening and grit removal processes would be housed in a headworks building and covered and vented for odor prevention. The headworks building would be a two-story building with an enclosed truck loading area. The channels inside the building would be covered and vented. The headworks building would be designed with a ventilation system that would maintain negative pressure under the covered processes and in the truck loading area to prevent the escape of process air into ambient air surrounding the headworks. Trucks would be covered before exiting the treatment plant. The air removed from this area would pass through odor prevention systems to treat the air before it is discharged to the atmosphere.

No additional maintenance air would be necessary because the primary scrubbers would handle any additional loading from uncovering a screen channel, for example.

Primary Treatment Ventilation System

The primary sedimentation basins and ballasted sedimentation basins would be covered with airtight covers and a ventilation system designed to maintain negative pressure under the covers. Process air from under these covers would be vented to an odor prevention system for treatment before discharge into the atmosphere.

Under maintenance conditions, one primary sedimentation basin would be drained at a time for major maintenance activities. Additional air would be required to ventilate the empty basin to provide for worker safety. Supplementary maintenance air scrubbers would be used for this purpose without any reduction of odor scrubbing ability.

Secondary Treatment Ventilation System

The secondary treatment system includes fine screens, aeration basins (which act as bioreactors), and membrane tanks (which house membranes that separate the liquids from the solids). All process tanks and screening channels would be covered and process air vented to an odor prevention system for treatment before discharge to the atmosphere.

Under maintenance conditions, one aeration basin and one membrane tank, together, would be drained for major maintenance activities. Additional air would be required to ventilate the empty basins. Supplementary maintenance air scrubbers would be used for this purpose.

Disinfection for Puget Sound Discharge Ventilation System

At the Route 9 site, the effluent from the membrane tanks would be blended with the effluent from the ballasted sedimentation prior to disinfection. Contact time for the disinfection, using sodium hypochlorite, would occur in the effluent tunnel. No contact chamber or onsite odor prevention would be required. Dechlorination using sodium bisulfite would occur in the effluent tunnel at Portal 5 or 26 between the treatment plant and Puget Sound.

At the Unocal site, ultraviolet (UV) light would be used for disinfection of the membrane bioreactor (MBR) effluent due to limited space onsite for chemical disinfection. The UV disinfection chamber would be a covered channel vented to an odor prevention scrubber. Sodium hypochlorite would be used for disinfection of the ballasted sedimentation effluent. This would also be covered and vented to the odor prevention system. The effluent from the membrane tanks would be blended with the ballasted effluent after disinfection and prior to discharge to Puget Sound. Process air from under these covers would be vented to an odor prevention system for treatment before discharge into the atmosphere.

Maintenance air for the disinfection chamber would be provided by the maintenance air system used for the aeration basins and MBR.

Disinfection for Reuse Ventilation System

UV disinfection would be used for the reuse disinfection system at both sites. Some sodium hypochlorite could be added in the distribution system after disinfection to prevent biofouling of the system. The reuse disinfection chambers would be covered and the process air vented to an odor prevention system before discharge to the atmosphere.

Maintenance air for the disinfection chamber would be provided by the maintenance air system used for the aeration basins and MBR.

4.3.2 Solids Processing and Biosolids Management Ventilation Systems

Solids handling consists of thickening primary and secondary sludge followed by anaerobic digestion, dewatering, and hauling of biosolids offsite for reuse.

Emergency Digester Gas Release Odor Prevention

Thickened sludge would receive a minimum of Class B stabilization through mesophilic anaerobic digestion in multiple cylindrical tanks. The digesters would be fully enclosed with fixed roofs. Only trace amounts of digester gas could escape through pressure relief vents during emergency conditions to prevent over-pressuring of the digester and its gas distribution and storage system. The digesters and digester gas distribution system would be designed to minimize any potential emergency digester gas venting. A carbon system would be located at all vents for odor prevention and would scrub the gas in the event of an emergency release.

Thickening and Dewatering Ventilation System

Solids would be thickened using gravity belt thickeners (GBTs) and dewatered using centrifuges. The thickening and dewatering equipment, as well as auxiliary storage, pumping equipment, and polymer addition system, would be contained in a three-story solids handling building. The solids handling building would be designed with a ventilation system designed to maintain negative pressure to capture the process air from the GBTs, centrifuges, conveyors, and truck loading area and treat it in an odor prevention system prior to discharge to the atmosphere.

No additional maintenance air would be necessary because the primary scrubbers would handle any additional loading from cleaning a GBT or centrifuge, for example.

Biosolids Truck Ventilation System

Dewatered biosolids would be transferred into trucks inside an enclosed loading/scale area in the solids handling building that would vent to an odor prevention system before discharge to the atmosphere. This area would be equipped with doors that would be closed after the truck enters, and the doors would not be opened until the truck was covered and the air in the loading bay purged and scrubbed. These emissions have been included in the solids handling emissions estimates. Because the ventilation system would be designed to keep the scale area under a negative pressure, normal operations would require that the doors be kept closed for proper operation. It is likely that an alarm would be generated within the plant control system whenever one of these doors is open, allowing improper operating conditions to be corrected.

Biosolids would either be directly loaded into the trucks from the dewatering devices (centrifuges) or stored in an enclosed tank to allow for loading into trucks independent of the dewatering operation. This loading would occur via an enclosed and ventilated conveyor system, or by means of an overhead hopper system. In either case, the entire process would be ventilated and the air treated in the odor prevention system before discharge to ambient air. The biosolids haul trucks would have covers designed to prevent any odors from escaping. Trucks located in the treatment plant site staging area and not inside the ventilated loading area would be hooked up to an odor prevention system. The system would include flexible ducts that attach to the trucks and pull air from the headspace between the cover and biosolids on full trucks and from the trailer on empty trucks. The air would be treated in an odor prevention system either near the truck staging area or in the solids handling building odor prevention system.

4.4 Targeted Odor Compounds

Total odors represent odors from all potential odor compounds that can be mixed together in the emissions from the source. Total odors include reduced sulfur compounds, amines, fatty acids, and mercaptans, along with ammonia and hydrogen sulfide. Odor compounds could be emitted from all Brightwater Treatment Plant sources, but some compounds could be emitted in the front end of the plant, generated in the plant, or be emitted from back-end and solids handling facilities. Different types of odor compound groups would also likely be emitted at various treatment processes throughout the plant.

Hydrogen sulfide generation is more prevalent in the influent pump station, headworks, and primary clarifiers than in downstream process units. Aeration basins are typically not significant sources of hydrogen sulfide or ammonia odor because of the biological activity taking place within the basin. The aeration basins have a distinct earthy or musty odor, but the odor typically does not have the intensity of hydrogen sulfide. Disinfection processes typically are not large odor sources at wastewater treatment plants and are commonly uncovered. However, disinfection would be covered at the Brightwater

Treatment Plant. Solids handling facilities are usually the largest producers of odor due to the high organic content of solids (compared to wastewater) and common anaerobic conditions. Many odorous compounds are represented in the solids processes, including hydrogen sulfide, ammonia, reduced sulfur compounds, amines, and organic acids.

The initial detection threshold (or first detectability of an odor) refers to the minimum concentration of an odorant that produces an olfactory response or sensation. The detection threshold (see Table 8) normally is determined by an odor panel, and the threshold value is determined when 50 percent of the panel detects an odor. Detection is different from recognition of the odor, and recognition thresholds are typically many times higher (WEF MOP 22). The Brightwater Treatment Plant's focus for odor prevention criteria is initial detection concentrations and not recognition levels. Odors at or slightly above the detection threshold are difficult, or nearly impossible, to perceive or recognize. Recognition thresholds are those reached when someone smells something that they recognize, like a rotten egg smell, and can correctly identify the substance (e.g., hydrogen sulfide).

TABLE 8
Hydrogen Sulfide, Ammonia, and Initial Odor Detection Thresholds

Parameter	Initial Detection Threshold
Hydrogen Sulfide	0.8 ppbV[a]
Ammonia	2,800 ppbV[a]
Odor	1 D/T

[a] Thresholds based on recent work done by St. Croix Laboratories for Sacramento Regional Sanitation District.

D/T = dilution to threshold
ppbV = parts per billion by volume

4.5 Quantification of Odor Impacts

Brightwater Treatment Plant's odor assessment approach applied successful experience from other similar plants to estimate emissions and calculate odor potency from each process area, and an atmospheric dispersion model to calculate ambient concentrations away from a source. Worst-case conditions were applied to confirm that all possible operating conditions would meet the stringent Brightwater Treatment Plant odor prevention goals. These additional conditions were:

- Modeling worst-case meteorological conditions (low wind speeds and inversion layers) and specific site meteorological conditions
- Assigning odor emission factors for all potentially odorous processes
- Assuming peak odor loading at all times even though peak odors typically could occur only during the summer and for short periods (a few hours) each day or less
- Defining Brightwater Treatment Plant ventilation needs to provide a safe workplace for operation and maintenance (O&M) staff and odor prevention during peak odor loading conditions, plant upset operating conditions, and emergency or routine process equipment maintenance

4.5.1 Ventilation Rates

All ventilation air would be pulled from the outside or surrounding building air into the process and then treated in the odor prevention system. This means that the covered systems and buildings would both be under negative air pressure and that all odorous process air would always be vented to the odor prevention system before discharge to the atmosphere. The general rule of thumb used for the Brightwater Treatment Plant was that occupied buildings would have 20 air changes per hour (ACH) and covered processes 12 ACH. The 20-ACH level provides operator safety by keeping the odor concentrations inside the buildings at a minimum. Air calculations based on ACH were compared to air calculations based on velocities (0.5 cfm divided by ft^2) and air volumes based on the hourly maximum air flow rates to the aeration basins and membrane tanks plus 10 percent to keep a negative pressure. In all cases, the highest value for the three methods was chosen and is shown in Tables 9 and 10. The highest values were calculated using the ACH method for all units except for aeration basins and membrane tanks. For aeration basins and membrane tanks, the maximum aeration air plus 10 percent was used to ensure a negative pressure at all times. The Unocal air flow would be slightly higher because there would be an onsite disinfection basin for Puget Sound discharge disinfection. Route 9 has no onsite disinfection basin and uses the effluent tunnel to provide the required contact time.

Each odor prevention source is further described in Attachment F, Liquids and Solids Process Source Parameters. The attachment includes number of stacks, air flow, stack diameter, stack height, and other parameters.

There is a tradeoff between ventilation rates and mass flux. Higher ventilation rates would produce a higher mass flux off the process units and therefore would produce a greater mass of odorous compounds to be treated in the odor prevention system. However, lowering the ventilation rates to lower the scrubber loading is not necessarily the best approach. Keeping higher ventilation rates provides a greater safety factor for maintaining a negative pressure in all process areas at all times (even when an operator lifts a hatch on a process to look inside) to ensure adequate capture of air under covers, to regulate the loading to the scrubbers to optimize performance, and to prevent deadspots under the covers, which would increase the corrosion potential. The potential for dead spots, corrosion, and fugitive emissions increases at lower ventilation rates. In addition, ventilation rates for buildings have taken code requirements into account, including National Fire Protection Act (NFPA) 820. Buildings must be adequately ventilated to ensure worker safety and also to provide a comfortable work environment so that doors and windows are not opened, which would allow fugitive odors to escape.

Maintenance air would be used when a tank is taken out of service. This is often the time when odor events occur due to the exposure of the residual solids or odorous wastewater to the ambient air. For the Brightwater Treatment Plant, to ensure that maintenance activities do not cause odor events and potential complaints, the odor prevention system would be designed with additional ventilation capacity to handle air flow from units out of service. The assumptions for this analysis were that one primary clarifier, one aeration basin, and one membrane tank would be out of service at the same time and require ventilation (at 12 ACH). The ventilation air in the empty basins would be sent to the maintenance air odor prevention scrubbers. The ventilation rates for maintenance air would be approximately 100,000 to 150,000 cfm for all processes combined.

TABLE 9
Summary of Air Flow Rates for Route 9 Site

Source	Normal Operations Ventilation Rate at 36 mgd (cfm)	Normal Operations Ventilation Rate at 54 mgd (cfm)
Influent Pump Station	63,000	63,000
Headworks, Primary Clarifiers, Ballasted Sedimentation, and Fine Screens	119,000	158,500
Aeration Basins, Membrane Tanks, and Reuse Disinfection	134,000	201,500
Solids Handling	74,000	111,000
Total	**390,000**	**534,000**

cfm = cubic feet per minute

TABLE 10
Summary of Air Flow Rates for Unocal Site

Source	Normal Operations Ventilation Rate at 36 mgd (cfm)	Normal Operations Ventilation Rate at 54 mgd (cfm)	Normal Operations Ventilation Rate at 72 mgd (cfm)
Influent Pump Station	63,000	63,000	63,000
Headworks, Primary Clarifiers, Ballasted Sedimentation, and Fine Screens	119,000	158,500	198,000
Aeration Basins, Membrane Tanks, and Disinfection (Reuse and Puget Sound Discharge)	138,500	208,000	277,000
Solids Handling	74,000	111,000	148,000
Total	**394,500**	**540,500**	**686,000**

cfm = cubic feet per minute
mgd = million gallons per day

The covers for the liquids processes would likely be concrete, with some removable hatches to allow for viewing the liquid. Any removable cover or hatch would be gasketed to prevent fugitive emissions. Some walk-in enclosures could also be provided so operators can observe the liquid surface as well as equipment (such as scum collection). The walk-in enclosures would be under negative pressure. The clean make-up air for the odor prevention system would enter through the walk-in enclosures.

4.5.2 Assumed Odor Concentrations

In general, the process air at the front end of the plant would be high in ammonia and hydrogen sulfide, which makes up the majority of the "odor." In the secondary process and disinfection, there would be little hydrogen sulfide, ammonia, or odors caused by reduced sulfur compounds, and few other chemical smells. In the solids processes, there would be more ammonia and less hydrogen sulfide than the liquid processes, and higher levels of reduced sulfur compounds, amines, and fatty acids. These together make up the "odor" from this process.

Table 11 shows the assumed peak concentrations at the surface of the liquid prior to dilution with ventilation air. All concentrations assume upstream chemical addition to reduce influent liquid total sulfide to 0.5 milligrams per liter (mg/L) or less. The assumed concentrations were chosen based on actual data from King County and other treatment plants. When converted to mass emissions, the hydrogen sulfide and ammonia concentrations chosen for the Brightwater Treatment Plant are more conservative than those predicted by BASTE, which is an inherently conservative model. The reason that the values below were used instead of values predicted by BASTE was to ensure that the Brightwater Treatment Plant would be designed for worst-case conditions and would be able to successfully treat and prevent offsite odor impacts under all conditions.

TABLE 11
Hydrogen Sulfide, Ammonia, and Odor Concentrations (without process air ventilation rates included) at Brightwater Treatment Plant

	Hydrogen Sulfide	Ammonia	Odor
Odor Source	**Peak ppmV**	**Peak ppmV**	**Peak D/T**
Influent Pump Station Wet Well	50	10	5,000
Headworks Building	50	10	5,000
Headworks (truck loading)	50	10	5,000
Aerated Grit Removal	50	10	5,000
Primary Clarifiers	50	10	5,000
Ballasted Sedimentation	50	10	5,000
Fine Screens	50	5	1,000
Aeration Basins	1	5	1,000
Membrane Tanks	1	5	500
Disinfection	0.5	1	100
Centrifuges	25	50	5,000
Conveyors	25	50	5,000
Biosolids Truck Loading	25	50	5,000
Gravity Belt Thickeners	25	50	5,000
Thickened Sludge Blend Tank	100	50	15,000

TABLE 11
Hydrogen Sulfide, Ammonia, and Odor Concentrations (without process air ventilation rates included) at Brightwater Treatment Plant

	Hydrogen Sulfide	Ammonia	Odor
Odor Source	Peak ppmV	Peak ppmV	Peak D/T
Raw Sludge Blend Tank	100	50	15,000
Centrate Tanks	25	50	5,000

Note: Chemical treatment in collection system and at influent pump station was assumed to maintain total sulfide ≤ 0.5 mg/L.

mg/L = milligram per liter
D/T = dilution to threshold
ppmV = part per million by volume

The process air collected from the enclosed and covered process units would be scrubbed using multistage (sodium hypochlorite, sodium hydroxide, and/or sulfuric acid) chemical scrubbers followed by activated carbon for additional odor reduction. Each stage treats the process air to a greater degree. The exhaust air from the scrubbers would be discharged from the scrubber stacks. The concentrations from Table 11 would be diluted with ventilation air prior to entering the odor prevention system. Table 12 shows the inlet concentrations to the odor prevention scrubbers, including the process ventilation air. As seen in Table 12, the concentrations modeled are much lower than those shown in Table 11. The higher ventilation rates result in more dilute concentrations entering the scrubber system, which reduces the odor peaks and valleys to allow for more consistent odor prevention performance. By having more consistent loadings to the scrubbers, the odor prevention system would be able to reliably meet the design criteria.

The 17 odor sources listed in Tables 11 and 12 are grouped into 4 odor prevention systems:

1. Influent pump station
2. Headworks, primary clarifiers, ballasted sedimentation, and fine screens
3. Aeration basins, membrane tanks, and disinfection
4. Solids handling building (centrifuges, conveyors, biosolids truck loading, gravity belt thickeners, thickened sludge blend tank, raw sludge blend tank, centrate tank)

The concentrations from each process are combined with the ventilation rates for each process. The individual sources combined together produce a flow-weighted concentration for each of the four systems.

TABLE 12
Scrubber Inlet Hydrogen Sulfide, Ammonia, and Odor Concentrations (including process air ventilation rates) at Brightwater Treatment Plant

	Hydrogen Sulfide	Ammonia	Odor
Odor Source	**Peak ppmV**	**Peak ppmV**	**Peak D/T**
Influent Pump Station Wet Well	7.52	1.50	752
Headworks Building	3.25	0.65	325
Headworks (truck loading)	0.98	0.20	98
Aerated Grit Removal	10.83	2.17	1083
Primary Clarifiers	7.65	1.53	765
Ballasted Sedimentation	10.83	2.17	1083
Fine Screens	3.25	0.33	65
Aeration Basins	0.10	0.50	101
Membrane Tanks	0.02	0.11	11
Disinfection	0.22	0.43	43
Centrifuges	0.9	1.76	176
Conveyors	25	50	5,000
Biosolids Truck Loading	0.1	0.12	12
Gravity Belt Thickeners	1	1.95	195
Thickened Sludge Blend Tank	7	3.25	975
Raw Sludge Blend Tank	9	4.33	1300
Centrate Tanks	2	3.25	325

Note: Chemical treatment in collection system and at influent pump station was assumed to maintain total sulfide ≤ 0.5 mg/L.

mg/L = milligram per liter
D/T = dilution to threshold
ppmV = part per million by volume

4.5.3 Technology Selection Process

To achieve the objectives above, high removal rates through a multistage system are required. Numerous technologies are available for odor prevention. Typically the most effective methods of odor prevention and control involve both liquid and vapor phase treatment. Not all odor generation can be prevented through liquid phase treatment, but liquid phase treatment can substantially mitigate odor generation and reduce the vapor phase treatment required if used properly. Experience at King County and other similar plants has shown that liquid phase treatment is most effective if used both in the wastewater collection system and at the influent pump station to reduce sulfide loading coming into the plant.

Evaluated Technologies

During pre-design of the odor prevention system, 10 liquid phase technologies were evaluated:

- Precipitation: iron salts (e.g., ferrous chloride, ferric chloride, ferrous sulfate)
- Inhibition: anthraquinone
- Inhibition: calcium nitrate (Bioxide™)
- Augmentation: organisms and enzymes
- pH control: caustic, lime, magnesium oxides/hydroxides
- Oxidation: chlorine compounds
- Oxidation: air/oxygen
- Oxidation: hydrogen peroxide
- Oxidation: ozone
- Oxidation: potassium permanganate

In addition, 11 vapor phase technologies were evaluated:

- Chemical scrubbers (packed towers)
- Chemical scrubbers (atomized mist)
- Biofilters
- Bioscrubbers/biotrickling towers
- Activated carbon
- Thermal oxidation
- Masking agents
- Counteractants
- Ozone
- Ionization
- Foul air to aeration basins for treatment

The selection of the odor prevention technologies was similar to that used for the BACT top-down process described previously in Section 2.3.1 of this appendix. During pre-design the overall evaluation process was developed and the criteria defined that were to be used in that process. A two-step process was selected in which alternatives could be progressively screened and evaluated.

In the first step, pass/fail screening criteria were applied to eliminate any technical alternative that did not meet basic King County requirements for Brightwater Treatment Plant. In the second step, the remaining alternatives were ranked using nonmonetary-focused criteria. Following the ranking, an initial evaluation of the shortlisted alternatives was performed. The alternatives were evaluated to see whether they could meet the odor prevention threshold goals for hydrogen sulfide, ammonia, and odor removal. Conceptual design level cost-benefit analyses were also performed. This is further described in the final report for Predesign Task 1.04 – Odor Prevention Technology Review and Impact Analysis.

Chosen Technologies

It was a complex procedure to select the vapor phase odor prevention treatment to meet King County's stringent goal of no detectable odors beyond the property line. Multistage scrubbers are necessary. Due to the varied odor loading at different process units, a first stage "rougher," or acid stage—which can remove ammonia or other targeted, hard to remove odors—was selected. A last stage "polisher" unit made up of carbon would be used. The scrubber system proposed for Brightwater Treatment Plant is shown in Figure 5. The vapor phase treatment technologies investigated during pre-design varied between two and five units in series (stages).

The chosen process includes the following components:

- Liquid phase treatment (one stage) in collection system using sodium hypochlorite, calcium nitrate, sodium hydroxide, or iron salts
  - Liquid phase treatment in the tunnel during the odor season (March – November)
  - Liquid phase treatment of the plant influent during the odor season (March – November)
- Three-stage chemical scrubbing (three stages) plus carbon scrubbing (one stage)

Brightwater Treatment Plant's odor prevention strategy focuses on proven, state-of-the-art odor prevention approaches (BACT) to provide large safety factors. The three-stage chemical scrubbers followed by activated carbon were sized for peak conditions. Spent chemicals would be discharged to the treatment plant (likely to the aeration basins). Redundant scrubber systems would be used when primary scrubbers are shut down for routine servicing and repairs. Dual electric feed and backup energy self generation would ensure that the scrubbers would be in service at all times unless a catastrophic failure of all three power supply systems were to occur. In addition, there would be additional scrubbers assigned to ventilate areas during routine maintenance activities (e.g., tank cleaning).

Conservative assumptions were used for removal rates (at peak loading) from each stage (actual removals could be higher) and are shown in Table 13.

TABLE 13
Removal Efficiencies of Each Odor Prevention Technology at Peak Loading (inlet gas – exhaust gas)

Removal Efficiencies	Hydrogen Sulfide Removal (%)	Ammonia Removal (%)	Odor Removal (%)
Chemical scrubber – acid stage	10	99	45
Chemical scrubber – caustic stage	80	10	80
Chemical scrubber – caustic/hypo stage	98	90	90
Carbon	97	20	85
Multistage System			
3-stage scrubber (acid + caustic + caustic/hypo) + carbon	99.99	99.93	99.84

4.5.4 Comparison to Other Treatment Plants

The Brightwater Treatment Plant would have an odor prevention and control system that is more sophisticated and comprehensive than most, if not all, treatment plants in the United States. Not only would all the process units be covered or enclosed with the process air treated in a multistage odor prevention system, but there would be several additional features that add factors of safety to the system. Table 14 compares the

Brightwater Treatment Plant odor prevention and control system to typical wastewater treatment systems in the United States.

TABLE 14
Comparison of Odor Prevention and Control Approach for Brightwater Treatment Plant to Other Wastewater Treatment Plants

Parameter	Typical Wastewater Plant	Brightwater Treatment Plant
Ability to capture all process air and eliminate odor sources and fugitive emissions	-	+
Treat the collection system and treatment plant as one odor generation system	0	+
Volume of process air requiring treatment	0	+
Ability to capture and treat peak emissions	-	+
Ability to treat range of odorous compounds	0	+
Ability to meet low offsite odor thresholds	-	+
Using combined approach of liquid and vapor phase treatment	0	+
Provisions for redundancy	-	+
Provisions for maintenance air treatment	-	+

0 = average
+ = above average
- = below average

4.5.5 Monitoring Effectiveness of Odor Prevention System

Monitoring the odor prevention system to ensure that it is working as designed would be paramount to the success of the odor prevention and control program. There are five components that would be monitored:

- **Continuous hydrogen sulfide measurements in the influent pump station wet well headspace**. The influent pump station wet well headspace would have hydrogen sulfide continuously monitored. This would allow for demand-based dosing of the chemical used for liquid phase treatment.

- **Routine exhaust gas monitoring and scrubber hydrogen sulfide removal efficiency checks for the scrubber trains**. All odor prevention scrubbers would have routine measurements of the inlet and outlet (stack) gas hydrogen sulfide concentrations to make sure that the scrubber operation would be optimized.

- **Continuous scrubber chemical dose optimization**. Scrubber monitoring systems would measure residual hydrogen sulfide in the scrubber exhaust. If the levels are below the detection thresholds at the stack, then the levels would be even farther below them at the property line. The monitoring would provide instant feedback to the chemical feed system to raise or lower the chemical feed rate.

- **Handheld instrument checks of exhaust gas hydrogen sulfide concentration.** Handheld instruments would be used to spot-check scrubber inlet and outlet concentrations to calibrate continuous monitoring equipment. Handheld instruments can be more sensitive than online instruments and can help refine chemical dosing and ensure that the scrubbers are performing as designed.

If the odor prevention system does not meet the design criteria for hydrogen sulfide, ammonia, or odor during routine operations, investigation of performance loss would be conducted using more refined analytical equipment. The sampling period could also be extended to ensure that the original sampling event was not caused by equipment parts failure, needs of equipment operating adjustments, or mistakes by the odor analysis laboratories. If refined sampling or repairs showed that the process's scrubbers still exceeded the design criteria, then each stage of the scrubber would be tested to see whether the scrubber stage that was not performing adequately could be identified. Scrubber inspections and O&M activities, such as scrubber cleaning or carbon replacement, could then be implemented. After the O&M activities, the scrubbers would be retested.

These monitoring procedures would be further refined in the design and startup phases. The monitoring would make certain that the existing scrubbing system functions optimally to meet the Brightwater Treatment Plant odor standard of no detectable odors at the property line.

4.5.6 Odor Impact Assessment

The odor impact assessment had two steps. First was to calculate the odor emissions, and second to enter the emissions into an air dispersion model to simulate offsite odor impacts.

Odor Emissions

Tables 15 through 17 show the hydrogen sulfide, ammonia, and odor concentrations, uncontrolled and controlled, assumed for the major treatment processes. The controlled mass emissions are also shown. These are the values input into the air dispersion model. The mass emissions for hydrogen sulfide and ammonia are in units of grams per second (g/s). The concentrations (as grams or micrograms per cubic meter ($\mu g/m^3$)) are multiplied by the dilution air (in cubic meters per second (m^3/s)) to get the mass emission in g/s.

Odor is the mixture of many compounds, all of which have different masses. The concentration of an odor sample is expressed as a volumetric ratio, dilution-to-threshold (D/T). The D/T is the amount of dilution from using clean air until you can no longer smell the odor. This is a unit of measure that is used for air volumes. If you have one unit of air (e.g., 1 liter) that smells like coffee, and it takes 20 liters of clean air (odorless air passed through a carbon filter) mixed with the coffee air until you no longer can smell anything, then the quantity of odor in the original sample was 20 D/T.

Odor concentrations are not specific to a particular compound. For hydrogen sulfide (and other compounds), it is possible to express its concentration in ppbV, which in fact is a volume ratio. However, the ideal gas law allows us to convert the portion that is hydrogen sulfide to a mass and change the volumetric concentration to a mass/volume concentration ($\mu g/m^3$). Because odor concentrations are not specific to a particular compound but a human response to all compounds present in the sample, it is not possible to convert the volumetric concentration (D/T) to a mass concentration.

For odor, the model input is D/T per second. It is not a concentration but rather a concentration per unit time. Odor cannot be modeled as a mass emission because it is not specific to an individual compound with a given mass; rather odor is a human response to all compounds present in the sample. Thus, the odor emission rate and corresponding odor standard are expressed as volumetric ratios.

Upstream liquid phase (chemical) treatment of the influent is assumed to keep the influent total sulfide concentration at or below 0.5 mg/L. The inlet concentrations are the concentrations shown in Table 12 and include ventilation air.

The odor emissions from 36 mgd were scaled up to the final design capacities of 54 mgd (for Route 9 and Unocal) and 72 mgd (for the Unocal Structural Lid sub-alternative only). The mass emissions were entered into an air dispersion model to determine offsite (beyond the plant property line) impacts. As plant flows increase from 36 to 54 or 72 mgd, concentration values would remain the same; however, mass discharge would increase as more surface area in the process tanks is exposed to ventilation air.

Route 9 and Unocal

The emissions were the same for both sites except that the Unocal site had additional odor prevention for disinfection for Puget Sound discharge (the Route 9 site would disinfect in the effluent tunnel), so the mass emissions were slightly higher due to the disinfection at Unocal.

The reason the inlet concentrations are the same for 36 mgd and 54 mgd for all except the influent pump station is that ventilation air flow for the influent pump station shaft would be the same at 36 mgd and 54 mgd. Therefore, the concentration in the process air from the wet well would be higher at the higher wastewater flow rate because the mass emissions would increase with higher flows. For the rest of the process units, the number of units would increase when moving from 36 mgd to 54 mgd. Therefore, the ventilation rates would also increase due to the additional surface area that would require ventilation. The inlet concentrations would be the same, but the mass emissions would increase due to the higher air flow rates.

TABLE 15
Grouped Emissions of Hydrogen Sulfide for 36-, 54-, and 72-mgd Treatment Plants

	Odor Prevention for 36-mgd Treatment Plant			Odor Prevention for 54-mgd Treatment Plant			Odor Prevention for 72-mgd Treatment Plant (Unocal Only)		
Emission Source	**Inlet H_2S (ppmV)**	**Outlet H_2S (ppmV)**	**Outlet H_2S (g/s)**	**Inlet H_2S (ppmV)**	**Outlet H_2S (ppmV)**	**Outlet H_2S (g/s)**	**Inlet H_2S (ppmV)**	**Outlet H_2S (ppmV)**	**Outlet H_2S (g/s)**
Influent pump station	7.52	0.00081	0.0000330	11.3	0.00121	0.0000495	15.02	0.00162	0.0000660
Headworks, primary clarifiers, ballasted sedimentation, and fine screens	3.14	0.00034	0.0000259	3.14	0.00034	0.0000346	3.14	0.00034	0.0000432
Aeration basins, membrane tanks, and disinfection	0.07	0.000008	0.000000617 (Rte 9) 0.000000677 (Unocal)	0.07	0.000008	0.000000924 (Rte 9) 0.00000102 (Unocal)	0.07	0.000008	0.00000136
Solids handling building	4.86	0.00053	0.0000249	4.86	0.00053	0.0000374	4.86	0.00053	0.0000498

g/s = gram/second
H_2S = hydrogen sulfide
mgd = million gallons per day
ppmV = parts per million by volume
Rte = Route

TABLE 16
Grouped Emissions of Ammonia for 36-, 54-, and 72-mgd Treatment Plants

	Odor Prevention for 36-mgd Treatment Plant			Odor Prevention for 54-mgd Treatment Plant			Odor Prevention for 72-mgd Treatment Plant (Unocal Only)		
Emission Source	**Inlet NH_3 (ppbV)**	**Outlet NH_3 (ppbV)**	**Outlet NH_3 (g/s[a])**	**Inlet NH_3 (ppbV)**	**Outlet NH_3 (ppbV)**	**Outlet NH_3 (g/s[a])**	**Inlet NH_3 (ppbV)**	**Outlet NH_3 (ppbV)**	**Outlet NH_3 (g/s[a])**
Influent pump station	1,500	1.10	0.0000440	2,250	1.70	0.0000659	3,000	2.20	0.0000879
Headworks, primary clarifiers, ballasted sedimentation, and fine screens	600	0.43	0.0000330	600	0.43	0.0000439	600	0.43	0.0000549
Aeration basins, membrane tanks, and disinfection	260	0.19	0.0000160 (Rte 9) 0.0000168 (Unocal)	260	0.19	0.00002.40 (Rte 9) 0.0000252 (Unocal)	260	0.19	0.0000337
Solids handling building	8,460	6.10	0.000289	8,460	6.10	0.000434	8,460	6.10	0.000578

g/s = gram/second
mgd = million gallons per day
NH_3 = ammonia
ppbV = parts per billion by volume
Rte = Route

TABLE 17
Grouped Emissions Odor for 36-, 54-, and 72-mgd Treatment Plants

	Odor Prevention for 36-mgd Treatment Plant			Odor Prevention for 54-mgd Treatment Plant			Odor Prevention for 72-mgd Treatment Plant (Unocal Only)		
Emission Source	**Inlet Odor (D/T)**	**Outlet Odor (D/T)**	**Outlet Odor (D/T/s)**	**Inlet Odor (D/T)**	**Outlet Odor (D/T)**	**Outlet Odor (D/T/s)**	**Inlet Odor (D/T)**	**Outlet Odor (D/T)**	**Outlet Odor (D/T/s)**
Influent pump station	752	1.24	37	1128	1.86	55.5	1504	2.48	74
Headworks, primary clarifiers, ballasted sedimentation, and fine screens	292	0.48	27	292	0.48	35.9	292	0.48	45
Aeration basins, membrane tanks, and disinfection	44	0.07	4.7 (Rte 9) 4.8 (Unocal)	44	0.07	7.1 (Rte 9) 7.2 (Unocal)	44	0.07	9.6
Solids handling building	931	1.54	54	931	1.54	81	931	1.54	108

D/T = dilution to threshold
D/T/s = dilution to threshold per second
g/s = gram/second
mgd = million gallons per day
ppmV = parts per million by volume
Rte = Route

Maximum Air Emissions for Hydrogen Sulfide and Ammonia

The mass of odorous compounds that is not removed in the odor prevention system is released to the atmosphere. The predicted worst-case, treatment-plant-wide hydrogen sulfide and ammonia mass air emission rates for both the Route 9 and Unocal sites at 54-mgd and 72-mgd (Unocal only) are shown below.

Compound	Emissions Without Odor Prevention (lb/yr)	Emissions With Odor Prevention (lb/yr)
54 mgd		
Hydrogen Sulfide	78,600	8.5
Ammonia	54,700	39.7
72 mgd (Unocal Only)		
Hydrogen Sulfide	102,800	11.1
Ammonia	72,600	52.5

Note: Odor not included in this table because odor is a combination of numerous odorous compounds, each with a different mass, and total mass cannot be quantified.

The mass emissions at Unocal for 54 mgd would actual be slightly higher than for Route 9 because of the additional air from the Puget Sound discharge disinfection process that would be treated by the odor prevention system. However, for this analysis, due to rounding of the data, they are considered equal.

Offsite Odor Impacts

The results of the odor modeling at both sites indicate that predicted impacts using onsite data and Paine field data would consist of no detectable odors beyond the property line of the treatment plant. The property line and offsite values are considerably lower than the detection thresholds for each parameter. The modeling approach was to use the highest peak loadings expected in the summer (Table 11) as year-round values to develop conservative worst-case estimates. The worst meteorological conditions occur in the winter when the atmosphere is very stable. The results shown in Tables 18 through 21 show the summer peak loadings with the winter meteorology, a condition that would never occur. The actual expected peak summer numbers would be lower than the values shown in Tables 18 through 21 and even farther below the odor detection thresholds. During peak events, the stack exhaust concentrations may not be below the initial detection threshold of 0.8 ppbV hydrogen sulfide and 1 D/T odor. However, stack concentrations during the worst-case, peak events are close enough to the initial detection thresholds to achieve the standard of no detectable odor beyond the site property line, even under peak conditions. A person would have to place their nose directly into the stack exhaust to register any faint odors, and the faint odors would dissipate quickly in very short distances from the stack exhaust.

Route 9

The maximum impacts would occur about 100 meters south of the site property line. The results are summarized in Table 18.

TABLE 18
Maximum Offsite Odor Impacts at Route 9 Site (at peak conditions)

Parameter	Onsite Meteorological Data	Paine Field Meteorological Data	Initial Detection Threshold
	36 mgd		
Odor (D/T)	0.004	0.006	1
H_2S (ppbV)	0.03	0.03	0.8
NH_3 (ppbV)	0.53	0.77	2,800
	54 mgd		
Odor (D/T)	0.006	0.007	1
H_2S (ppbV)	0.04	0.05	0.8
NH_3 (ppbV)	0.79	0.96	2,800

D/T = dilution to threshold
H_2S = hydrogen sulfide
mgd = million gallons per day
NH_3 = ammonia

Figure 6 shows the relationship between the detection threshold, the annual maximum (or 3-minute peak) concentrations, and the annual average concentrations at 36 mgd using onsite meteorological data. These values are measured at the point of maximum impact, which for Route 9 would be 100 meters south of the property line. The maximum is the highest value recorded of all the receptors during the period modeled. The average is the average of every 3-minute value at the receptor with the maximum impact over the time period modeled.

A comparison of detection thresholds to average offsite concentrations at Route 9 for odor, hydrogen sulfide, and ammonia is shown in Table 19.

Unocal

The maximum impacts occur along the southwest site property line. The results are summarized in Table 20.

Figure 7 shows the relationship between the detection threshold, the annual maximum (or 3-minute peak) concentrations, and the annual average concentration at 36 mgd using onsite meteorological data. These values are measured at the point of maximum impact, which for Unocal would be along the southwest site property line. The maximum is the highest value recorded of all the receptors during the period modeled. The average is the average of every hourly value at the receptor with the maximum impact over the time period modeled.

The amount that the average offsite concentration at the highest receptor is below the detection thresholds for odor, hydrogen sulfide, and ammonia is shown in Table 21.

TABLE 19
Comparison of Detection Thresholds to Average Offsite Concentrations at Route 9 Site (36 mgd)

Parameter	Initial Detection Threshold	Average Offsite Concentration
Odor	1 D/T	0.0002 D/T (5000 times less than initial detection threshold)
Hydrogen Sulfide	0.8 ppbV[a]	0.002 ppbV (400 times less than initial detection threshold)
Ammonia	2,800 ppbV[a]	0.018 ppbV (155,000 times less than initial detection threshold)

[a] Threshold based on recent work done by St. Croix Laboratories for Sacramento Regional Sanitation District.

D/T = dilution to threshold
ppbV = parts per billion by volume

TABLE 20
Maximum Offsite Odor Impacts at Unocal Site (at peak conditions)

Parameter	Onsite Meteorological Data	Paine Field Meteorological Data	Initial Detection Threshold
36 mgd			
Odor (D/T)	0.02	0.01	1
H_2S (ppbV)	0.20	0.10	0.8
NH_3 (ppbV)	0.68	0.93	2,800
54 mgd			
Odor (D/T)	0.03	0.02	1
H_2S (ppbV)	0.30	0.14	0.8
NH_3 (ppbV)	1.08	1.30	2,800
54 mgd with structural lid			
Odor (D/T)	0.03	0.02	1
H_2S (ppbV)	0.30	0.14	0.8
NH_3 (ppbV)	1.31	1.30	2,800
72 mgd			
Odor (D/T)	0.04	0.02	1
H_2S (ppbV)	0.39	0.19	0.8
NH_3 (ppbV)	1.51	1.48	2,800

TABLE 20
Maximum Offsite Odor Impacts at Unocal Site (at peak conditions)

Parameter	Onsite Meteorological Data	Paine Field Meteorological Data	Initial Detection Threshold
	72 mgd with structural lid		
Odor (D/T)	0.04	0.02	1
H_2S (ppbV)	0.40	0.19	0.8
NH_3 (ppbV)	1.71	1.48	2,800

D/T = dilution to threshold
H_2S = hydrogen sulfide
mgd = million gallons per day
NH_3 = ammonia

TABLE 21
Comparison of Detection Thresholds to Average Offsite Concentrations at Unocal Site (36 mgd)

Parameter	Initial Detection Threshold	Average Offsite Concentration
Odor	1 D/T	0.0001 D/T (10,000 times less than initial detection threshold)
Hydrogen Sulfide	0.8 ppbV[a]	0.0008 ppbV (1,000 times less than initial detection threshold)
Ammonia	2,800 ppbV[a]	0.013 ppbV (215,000 times less than initial detection threshold)

[a] Threshold based on recent work done by St. Croix Laboratories for Sacramento Regional Sanitation District.

D/T = dilution to threshold
ppbV = parts per billion by volume

5 AIR QUALITY IMPACTS ASSESSMENT

5.1 Introduction

This section describes the air quality impacts assessment starting with the approach used for the Brightwater Treatment Plant, and followed by a description of the air pollutant sources at the treatment plant, the targeted compounds, and a quantification of the offsite air quality impacts.

5.2 Air Pollutants Control Approach

Criteria, hazardous, and toxic air pollutants (HAPs and TAPs) generated during the treatment process as volatile organic chemicals present in the influent wastewater are released from the liquid or sludge to the air. Criteria pollutants, HAPs, and TAPs are also generated from combustion sources at the treatment plant. For a facility of this size, air pollutants generated from the liquid and solid treatment processes are typically discharged directly to the atmosphere without treatment because they are generally generated in trace amounts below federal, state, and local air quality regulations. The Brightwater Treatment Plant odor prevention system would have carbon scrubbers that could potentially remove VOCs and air toxics (air toxics are the list of TAPs and include HAPs). Some percentage of the volatile organics could adsorb to the carbon. However, for this analysis no credit was given to the possibility of adsorption to carbon. All nonodorous emissions from the liquids and solids treatment process were assumed to be released into the atmosphere, and impacts to the environment were based on this assumption of zero percent adsorption to the carbon.

5.3 Sources of Air Pollutants

5.3.1 Liquids and Solids Treatment Facilities

The following treatment facilities at the treatment plant would generate trace levels of VOCs and air toxics (TAPs and HAPs):

- Influent pump station
- Headworks (screening and degritting)
- Primary sedimentation basins
- Ballasted sedimentation basins
- Aeration basins
- Membrane tanks
- Disinfection for Puget Sound discharge (Unocal only; disinfection at Route 9 occurs in the effluent tunnel)
- Disinfection for reuse

The liquids and solids treatment process are the same as those described in Section 4.3, Odor Sources. The additional sources are combustion sources, which are described below.

5.3.2 Combustion Sources

Four types of combustion sources were considered when evaluating air emissions from the facility:

- Co-generation turbines operating on digester gas and natural gas
- Standby (emergency) internal combustion engines operating on diesel
- An enclosed flare (for combustion of digester gas when the cogenerators are down)
- Hot water boilers for heating during the winter, operating on natural gas

All of the combustion units except the enclosed flare were assumed to be located in the co-generation building. The flare would be located near the digesters.

Diesel-Fired Standby Internal Combustion Engine Generator

Two independent power feeders would provide power to the Brightwater Treatment Plant to meet redundancy and standby power requirements. In addition, diesel-fired onsite generation would be provided for critical life safety requirements.

Co-Generation Turbines

Co-generation turbines (cogens) were assumed to be used as an onsite power generation source capable of providing sufficient power (using digester gas and natural gas) to run the entire treatment plant facility at annual wastewater flow capacity, including the influent pump station if electrical power from the dual electric feed is not available. Under normal operation, the cogens would run using digester gas to offset the electricity required from the grid. It is possible that reciprocating engines could be used instead of turbines if new control technology becomes available that would allow them to pass the ASILs (currently not the case).

Enclosed Flare

For this analysis, the enclosed flare was assumed to be operated only when the cogens are unable to accept digester gas continuously. Operation of the flare is not expected, so it was assumed that the flare would operate no more than 500 hours per year.

Natural Gas-Fired Hot Water Boilers

Although the heat recovery from the cogen units would likely provide sufficient heat, this analysis also assumed that natural gas-fired hot water boilers would be used to heat the treatment plant buildings for 8 months of the year (the winter heating season).

Assumptions were made regarding the types of combustion units, configuration, and capacity of the units. Final selection, configuration, and capacity would be determined during project design. The combustion equipment used in the final design would require a NOC permit, use BACT and TBACT, and demonstrate that TAP emissions would be less than the ASILs.

5.4 Aerosols from Wastewater Treatment Processes

Aerosols are small, airborne droplets that could be generated in the aerated grit, aeration basins, biosolids handling and treatment facilities, or other aerated wastewater processing areas. There should be no significant emissions of aerosols from the Brightwater Treatment Plant. The design of the liquid treatment processes includes covers for all liquids and solids handling processes. Emissions of aerosols from the liquid processes would be collected by the covers and either re-entrained in the wastewater or sent to the odor prevention system for removal or re-entrainment in the scrubber’s wastewater. Because all wastewater and solids handling processes are covered or enclosed in buildings at Brightwater Treatment Plant, aerosols should stay in the process or be carried and treated in the odor prevention system before discharge to the atmosphere.

5.5 Targeted Criteria and Toxic Compounds

Criteria air pollutants as well as HAPs and TAPs were evaluated in this analysis. The compounds evaluated are:

Nitrogen oxides
Carbon monoxide
Particulate matter (<10 microns)
Particulate matter (<2.5 microns)
Sulfur dioxide
VOCs
2-Methylnaphthalene
Acetaldehyde
Acrolein
Acrylonitrile
Ammonia
Arsenic
Barium
Benzene
Butane
Cadmium
Carbon tetrachloride
Chlorobenzene
Chloroform
Chromium
Dichlorobenzene
Dichloroethane
Ethylbenzene
Ethylene dibromide
Fluoranthene
Fluorene
Formaldehyde
Hexane
Hydrogen Sulfide
Lead
Manganese
Mercury
Methylene chloride
Methyl chloroform (1,1,1 Trichloroethane)
Molybdenum
Naphthalene
Nitric oxide
PAH
Pentane
Phenanthrene
Pyrene
Selenium
Styrene
Tetrachloroethylene (perchloroethylene)
Toluene
Trichloroethane
Trichloroethylene
Vanadium
Vinyl chloride
Vinylidene chloride
Xylene
Zinc

5.6 Quantification of Criteria and Toxic Pollutant Impacts

5.6.1 Ventilation Rates

The ventilation rates for the liquids and solids processes are the same as those described in Section 4.5.1, Ventilation Rates. Each odor prevention source is further described in Attachment F, Liquids and Solids Process Source Parameters. For combustion sources, the exhaust rates and physical parameters are described in Attachment E, Combustion Source Parameters.

5.6.2 Assumed Influent Concentrations

Assumptions were made for the influent wastewater concentrations of several HAPs. These influent concentrations are provided in Attachment D. Three compounds (acrolein, methylene chloride, and trichloroethylene) were not available from AMSA; thus, concentrations for these compounds were compiled from several POTWs that have influent concentrations similar to those of the Brightwater facility.

The influent concentrations were chosen from sources that have been accepted by many states, many local air quality regulatory agencies, and EPA as one of the best ways to estimate air emissions from POTWs. In addition, these influent concentrations have been used in many POTW Title V and states' operating permit programs and approved permit applications. Influent data from King County's South Treatment Plant were reviewed, but were less conservative for total influent HAPs. Therefore, the more conservative AMSA and other POTWs values were chosen for modeling.

The references chosen to determine the emission factors used for each source are summarized in Table 22.

TABLE 22
Summary of Criteria and Toxic Air Pollutants Emission Factor Sources

Air Emission Source	Reference for Emission Factors
Influent Pump Station	AMSA/BASTE
Headworks	AMSA/BASTE
Primary Sedimentation Basins	AMSA/BASTE
Aeration Basins	AMSA/BASTE
Membrane Bioreactors	AMSA/BASTE
Thickening	POTW Database
Dewatering	PEEP
Co-Generation Turbines	Section 3.1 of AP-42 + So-Low-NOx
Diesel Internal Combustion Engines	Section 3.3 of AP-42 and 40 CFR Chapter I Part 89 Tier 2 Standards
Enclosed Flare	Section 13.5 of AP-42
Natural Gas Boilers	Section 1.4 of AP-42 + low NOx burner

AMSA = Association of Metropolitan Sewage Agencies
BASTE = Bay Area Sewer Toxics Emissions
CFR = Code of Federal Regulations
PEEP = Pooled Emission Estimation Program
POTW = publicly owned treatment works

Emission factors from AP-42 are typically used for new facilities. AP-42 is a compilation of actual source test data from numerous facilities. The AP-42 emission factors provide a baseline emission rate. The actual emission rate would be determined during source testing as required during the air permitting process.

5.6.3 Technology Selection Process (BACT)

Liquids and Solids Processes

BACT for VOCs in wastewater is typically implemented through source control programs. King County does this through its industrial pretreatment program. Carbon adsorption is also considered BACT for some VOCs once they move from the liquid phase to the vapor phase. For other compounds, the relative humidity of the air renders sorption to the carbon impossible. For this analysis, no credit was given for the removal of TAPs and HAPs by the carbon, and all nonodorous emissions were assumed to be released directly to the atmosphere. This is a conservative approach that could potentially overestimate the emissions from the liquids and solids treatment processes.

Co-Generation Turbines

As part of the air permitting process, the turbines would be required to meet BACT. As with other emission sources, BACT and TBACT for the co-generation turbines must be determined on a case-by-case basis at the time of permitting. For this Final EIS, the control technologies used to estimate emissions from the co-generation facility at the Brightwater Treatment Plant are based on the selection King County made for the South Wastewater Treatment Plant in the NOC application (Kennedy/Jenks Consultants, 2003). The BACT analysis for the South Plant NOC recommended So-Low-NOx combustion technology, which has a guaranteed emission limit of 25 ppm NOx and 50 ppm CO at 15 percent oxygen. A BACT analysis for the Brightwater Treatment Plant would be conducted when a NOC application is submitted for the facility, because new technologies may be available at that time.

EPA is in the process of developing MACT standards for turbines and reciprocating engines. The combustion technology used in the NOC application would need to comply with the applicable proposed or adopted MACT standard at the time of permitting.

Diesel-Fired Standby Internal Combustion Engine Generators

The engines were assumed to meet Tier 2 emission standards for NOx, hydrocarbons, CO, and particulate matter as specified in 40 CFR Chapter I Part 89 for off-highway IC engines; however, more stringent Tier 3 standards are likely to be in effect by the time the engines are installed.

Enclosed Flare

AP-42 does not include specific emission factors for digester gas flares, so the emission factors for industrial flares (from Section 13.5 of AP-42) were used. No BACT determination was made for the flares. A regenerative thermal oxidizer (RTO) may be used instead of a flare. It is more conservative to use flare emissions because they are generally higher.

Natural Gas-Fired Hot Water Heaters

A BACT analysis for the hot water boilers was not conducted at this time, but would be conducted for the NOC application. However, low-NO_x burners were assumed to be installed on the boilers because this is generally required on all boilers of this size.

5.6.4 Air Quality Impacts Assessment

Air quality impacts were assessed for two conditions:

- Construction phase
- Operations phase

Construction Phase

Although construction impacts are temporary, they would be mitigated based on the requirements of the PS Clean Air for minimizing air quality impacts to ambient air. PS Clean Air Regulation I Section 9.15 states, “No person shall allow visible emissions unless reasonable precautions are employed.” Construction emissions would be mitigated by watering roads, covering loaded dump trucks, washing truck tires prior to them exiting the construction area, and minimizing idling vehicle times. As is customary at construction sites, traffic could be rerouted to minimize impacts by using detours, lane closures, and flag persons to control traffic flow. Traffic provisions are aimed at reducing emissions by moving construction traffic in and out of the area promptly to reduce vehicle emissions impacts. For Unocal, a shuttle for construction workers could be used. The shuttle would bring workers to the site from offsite parking lots. There would also be a remote construction truck holding area to minimize conflicts to the ferry traffic movement along SR 104, schedule construction material delivery to the site during offpeak hours, and encourage workers to carpool to the construction site.

PS Clean Air has the responsibility to determine compliance with its Regulation I, Section 9.15. Washington State and Federal Operational Safety and Health Act (OSHA) regulations for worker safety during construction may also require onsite monitoring to ensure that worker health and safety standards are met. This would include monitoring air contaminants that could be emitted to the air from contaminated soil or groundwater. Failure to comply with these standards would result in curtailing or stopping the activity that was producing violations.

Final EIS Chapter 16, Transportation, includes traffic estimates of the number of trucks trips to be used during construction.

Route 9 Site

The history of land uses at the Route 9 site (auto wrecking yards) indicates that some contaminants could potentially have leaked from vehicles and other sources. However, the expected concentration of these chemicals in the soil and the volumes of material to be excavated from the site are less than at the Unocal site. Therefore, air emission impacts from the cleanup of contaminated soils and fugitive dust should be less for the Route 9 site than for the Unocal site.

Because less excavated material would be removed from the Route 9 site than the Unocal site, the number of haul truck trips would be fewer, resulting in lower air impacts from the combustion of diesel in haul trucks. The potential for impacts would be short term, occurring only while demolition or construction work is in progress. No significant long-term adverse impacts on local or regional air quality are anticipated.

Unocal Site

Potential air emissions from construction at the Unocal site could be generated due to possible emissions of contaminants present in groundwater or soil at the site. These contaminants (which would be classified as TAPs or HAPs under applicable regulations) could volatilize, or disperse into the air, if the soil or groundwater containing them were disturbed. Cleanup of the contamination at the Unocal site could follow two scenarios:

- Unocal could clean up all known contamination and bring the site up to Ecology’s requirements before selling the site to King County, or
- King County could purchase the site and take over responsibility for site cleanup.

If Unocal were to clean up the site prior to sale, emissions of these contaminants would not take place during treatment plant construction because the contamination would have been removed prior to the County’s acquisition of the site. Because a decision has not yet been made regarding site cleanup timing and responsibility, potential impacts based on currently available information are discussed in this section.

Information on soil contaminant concentrations is available for the Unocal site. The information presented here is from the most recent interim action performed by Unocal at the site. The interim action consisted of removal of contaminants in soil and groundwater from four areas in the lower yard. The work was performed from August through October 2001. Data were obtained from *Draft Lower Yard Interim Action, As-Built Report, Unocal Edmonds Terminal* (Maul, Foster, and Algoni (MFA), 2002). This information is used here because it is the most recent data and it represents contaminant concentrations present in soil that likely would be excavated if construction were to begin in the near future.

The interim action consisted of removing soil that was visibly saturated with petroleum product to a depth below the water table surface (which fluctuates several feet daily under tidal influence). The excavations then were left open for 1 month to allow petroleum product to accumulate on water in the excavation. Unocal then removed the product using skimmer type pumps. The excavations were backfilled with clean, imported material. Prior to backfilling, samples were obtained from the excavation sidewalls to document total petroleum hydrocarbon (TPH) concentrations in the unsaturated soil at the excavation limits. The samples were analyzed for gasoline-range (GRO), diesel-range (DRO), and heavy-oil-range (HO) hydrocarbons; benzene, toluene, ethylbenzene, and xylenes (BETX); and polycyclic aromatic hydrocarbons (PAHs). The report does not include the exact locations of the samples, but all the excavations were located in the lower yard.

Table 23 presents the results of soil sampling conducted in the excavations. Included are four samples: one with the highest concentration in the diesel range (designated as “Maximum D” in the table); one with the highest concentration in the gasoline range (designated as “Maximum G”); one with a moderate or “Medium” concentration (but not an average); and one with a low concentration.

TABLE 23
Contaminants Present in Unocal Site Soils, August – October 2001

Contaminant	Maximum D (mg/kg)	Maximum G (mg/kg)	Medium (mg/kg)	Low (mg/kg)
TPH-Diesel Range (DRO)	35,100	2830	1320	254
TPH-Heavy Oil Range (HO)	10,900	1790	1040	214
TPH-Gasoline Range (GRO)	147 J	2060	363J	8.93J
Benzene	<0.0600	1.36J	0.0681	<0.0300
Ethylbenzene	0.169	17.1	0.551	<0.0500
Toluene	<0.100	<1.00	<0.0500	<0.0500
Total Xylenes	1.01 J	31.4	1.44	<0.100
Benzo(a)pyrene	<0.028	<0.0055	0.057	0.025
Benzo(a)anthracene	0.24	0.12	0.098	0.034
Benzo(b)fluoranthene	<0.030	<0.0060	<0.0060	<0.0012
Benzo(k)fluoranthene	<0.040	<0.0080	<0.0080	<0.0016

TABLE 23
Contaminants Present in Unocal Site Soils, August – October 2001

Contaminant	Maximum D (mg/kg)	Maximum G (mg/kg)	Medium (mg/kg)	Low (mg/kg)
Chrysene	1.3J	0.24	0.16	0.1
Dibenzo(a,h)anthracene	<0.035	<0.0070	<0.0070	<0.0014
Indeno(1,2,3-cd)pyrene	<0.048	<0.0095	<0.0095	0.02

Source: *Draft Lower Yard Interim Action, As-Built Report, Unocal Edmonds Terminal* (Maul, Foster, and Algoni, 2002)

"J" = qualifier indicating estimated value
"D" = diesel
"G" = gasoline
mg/kg = milligram per kilogram

Based upon the contaminant levels in Table 23, only benzene and PAH appear to have the potential to exceed the SQER. Thus, it is likely that air quality regulatory agencies would require dispersion modeling for benzene and PAH if site cleanup had not been completed before King County undertook construction of a treatment plant at the Unocal site. Dispersion modeling for these contaminants was not conducted for this EIS because the amount of contaminated material to be excavated and the period over which the excavation of this material would be completed (both critical factors in dispersion modeling) are not known at this time.

Operations Phase

The air impact assessment for the operations phase had two steps. First was to calculate the air emissions from the treatment plant liquids, solids, and combustion sources, and second was to enter the emissions into an air dispersion model to simulate offsite impacts.

The emission estimates are for potential yearly and maximum daily emissions. The estimate of potential yearly emissions assumed that all liquids, solids, and combustion units are operating at the design capacity. Because the facility has the ability to operate the standby engine and the enclosed flare from 0 to 500 hours a year, which would result in the cogen turbines operating from 8,260 to 8,760 hours per year (assuming no electricity is available from the dual feed), the maximum potential yearly emissions for each pollutant were based on the source with the highest emission factor operating the maximum hours allowed. Emissions from liquids and solids processes were added to emissions from combustion sources. In addition, the maximum daily emissions estimated the maximum potential emission for each pollutant in a 24-hour period. For example, the standby diesel engines would not operate at the same time as the cogen turbines. For some pollutants the daily emissions would be higher if the engines operated for 24 hours, but for other pollutants the daily emissions would be higher if the turbines were operated for 24 hours. Because the maximum daily emission for each pollutant was based on the highest emission rate for that pollutant, some of the emission rates are with the cogens operating and some are with the diesel engines operating. The actual daily maximum for the sum total of all the pollutants would always be less than this estimate, because all these units would not be operated concurrently.

The approach used for Brightwater Treatment Plant was to assume the worst-case or peak operating condition for all sources to establish the highest possible emissions for criteria pollutants, HAPs, and TAPs. In reality, all facilities may not operate at their peak condition at the same time. However, this approach is appropriately conservative for modeling at this level of design. If the Brightwater Treatment Plant can meets its air toxics and other air quality criteria with these assumptions, and because further refinements would likely make the assumptions less conservative, then the Brightwater Treatment Plant's air emissions would not adversely impact its neighbors.

Air Emissions

Air emissions at the treatment plant are from three sources: liquids processes, solids processes, and combustion sources.

Liquids Treatment Emissions

Volatile organic compound (VOC) and HAP emissions were estimated using the BASTE model and the POTW database. The individual compounds and influent concentrations modeled are from AMSA and are included in Attachment D. The influent concentrations for the King County South Treatment Plant were reviewed, but the total mass loading for the AMSA values was more conservative and therefore AMSA values were used.

The emissions from the liquids processes are captured under the covers and vented to the odor prevention system as described in Section 4.2, Odor Sources.

All compounds were modeled by BASTE or estimated using data from similar type POTWs except ethylene dibromide and vinylidene chloride. These compounds were not available in BASTE, and a mass balance approach using influent data from AMSA was used to determine these HAP emissions. The mass balance method is conservative because it assumes that the entire influent mass is completely volatilized and does not account for the sorption or biodegradation that typically occurs at a POTW for most VOCs, HAPs, and TAPs.

Because all the identified HAPs and TAPs from the liquid treatment processes are also volatiles, the VOC emission rate was calculated by adding up the individual HAP and TAP emission rates, plus other pollutants that are VOCs and not either a HAP or TAP.

Solids Treatment Emissions

VOC and HAP emissions from the solids treatment processes result from three processes: gravity belt thickeners (GBTs), digesters, and dewatering centrifuges. The emissions from dewatering centrifuges were estimated using the Pooled Emission Estimation Program (PEEP). PEEP was established to develop a POTW industrywide estimation method for air toxic emissions from 18 POTW unit processes. PEEP quantified air emissions using uniform protocols for sampling and analysis, which were approved by local air regulators and reviewed by state and national air pollution agencies. The annual average emission rates at other POTWs were adjusted using the appropriate sludge flow rates for Brightwater Treatment Plant. PEEP and POTW emissions were used because they have been accepted by local, state, and federal regulatory agencies and used in many existing POTW Title V and state-required air quality operating permits. The emissions from the GBTs at the Brightwater Treatment Plant were estimated using the appropriate sludge flow rates for the Brightwater Treatment Plant and actual annual emissions from GBTs at other POTWs. This emission factor was completed under the guidance developed by PEEP.

Because all the identified HAPs and TAPs are also volatiles, the VOC emission rate was calculated by adding up the individual HAP and TAP emission rates, plus other pollutants that are VOCs and not either a HAP or TAP. Hydrogen sulfide and ammonia emission are included in the odor emissions section and plant-wide emissions.

Site-Specific Treatment Emissions

Route 9. HAP and TAP emissions were estimated for the Route 9 treatment plant operating at its Phase 1 design level of 36 mgd, and the final design stage of 54 mgd (Table 24).

TABLE 24
Toxic and Hazardous Air Pollutant Emissions from Liquids and Solids Handling Processes at Route 9 Site (no emission controls)

Chemical Compounds	Total Emissions from Liquid and Solids Handling Processes at 36 mgd (lb/yr)	Total Emissions from Liquid and Solids Handling Processes at 54 mgd (lb/yr)
VOCs (including TAPs and HAPs)	**3,584**	**5,054**
Acrylonitrile	3	5
Benzene	78	102
Carbon tetrachloride	11	16
Chlorobenzene	71	92
Chloroform	659	961
1,4 Dichlorobenzene	120	158
Ethyl benzene	65	86
Ethylene dibromide	2	3
Methylene chloride	137	205
Methyl chloroform (1,1,1 Trichloroethane)	476	693
Styrene	22	29
Tetrachloroethylene (perchloroethylene)	963	1,401
Toluene	387	507
Trichloroethylene	90	135
Vinyl chloride	2	3
Vinylidene chloride	27	41
Xylenes	471	617

lb/yr = pound per year
mg/kg = milligram per kilogram

Unocal. HAP and TAP emissions were estimated for the Unocal treatment plant operating at its Phase 1 design level of 36 mgd, the final design stage of 54 mgd, and the 72-mgd sub-alternative (Table 25).

TABLE 25
Toxic and Hazardous Air Pollutant Emissions from Liquids and Solids Handling Processes at Unocal Site (no emission controls)

Chemical Compounds	Total Emissions from Liquid and Solids Handling Processes at 36 mgd (lb/yr)	Total Emissions from Liquid and Solids Handling Processes at 54 mgd (lb/yr)	Total Emissions from Liquid and Solids Handling Processes at 72 mgd (lb/yr)
VOCs (including TAPs and HAPs)	**3,584**	**5,054**	**6,595**
Acrylonitrile	3	5	6
Benzene	78	102	126
Carbon tetrachloride	11	16	22
Chlorobenzene	71	92	114
Chloroform	659	961	1,283
1,4 Dichlorobenzene	120	158	195
Ethyl benzene	65	86	107
Ethylene dibromide	2	3	4
Methylene chloride	137	205	273
Methyl chloroform (1,1,1 Trichloroethane)	476	693	925
Styrene	22	29	36
Tetrachloroethylene (perchloroethylene)	963	1,401	1,871
Toluene	387	507	629
Trichloroethylene	90	135	179
Vinyl chloride	2	3	4
Vinylidene chloride	27	41	55
Xylenes	471	617	764

lb/yr = pound per year
mg/kg = milligram per kilogram

Combustion Sources

Criteria pollutant, HAP, and TAP emission estimates for the combustion sources were developed using emission information provided by EPA's AP-42, Compilation of Air Pollution Emission Factors, and 40 CFR Chapter I Part 89, which regulates emissions from off-highway internal combustion engines. As the treatment plant's design continues to develop and more specific information about the emission units can be provided by the selected vendors, the accuracy of the emission estimates would improve and most likely produce lower emission rates.

Assumptions were made regarding the types of combustion units, configuration, and capacity of the units. Final selection, configuration, and capacity would be determined during project design. The combustion equipment used in the final design would require a NOC permit, use BACT and TBACT, and demonstrate that TAP emissions would be less than the ASILs.

Assumptions related to the capacity and operating hours of combustion equipment are crucial in determining emissions. Potential emissions are based on the combustion sources running at rated capacity, or maximum digester gas flow rates, for the maximum allowed time period. Additional information about assumptions used in characterizing the emissions is provided below and in a later Section titled Offsite Air Quality Impacts.

Operating scenarios could include:

- Using digester gas and natural gas to generate electricity for the average wet weather plant flow (including the influent pump station)
- Using the emergency internal combustion engines during power failures to serve essential life and safety needs and to restart the cogen units
- Flaring digester gas when the cogen units are inoperable

Co-Generation Turbines

The cogen equipment used in the final design would require a NOC permit, use BACT and TBACT, and demonstrate that TAP emissions would be less than the ASILs. The cogens would use digester gas and natural gas as fuel. The peak digester gas production of the 54-mgd treatment plant is estimated at 1,100 cfm, with an average yearly production of 398 cfm at 54 mgd. Potential emissions were calculated assuming the turbines would operate at maximum load 365 days a year. The yearly fuel requirements were provided by a daily average of 398 cfm of digester gas, with the remaining fuel requirement provided by natural gas. The daily fuel requirements were provided by peak daily rate of 1,100 cfm of digester gas, with the remaining fuel requirement provided by natural gas. In calculating the maximum 24-hour emission rate, if the emission factor for a specific toxic chemical was higher for natural gas than the emission factor for digester gas, all the fuel requirement was assumed to be provided by natural gas. Section 3.1 of AP-42 provides emissions for turbines operating on digester gas and natural gas, which were used in the modeling. The estimated heat content of the digester gas is 600 British thermal units (Btu) per cubic foot.

The primary criteria pollutants that could be emitted from the co-generation facilities are oxides of NO_x, CO, particulate matter less than 10 microns in diameter (PM_{10}) and less than 2.5 microns (PM2.5), and SO_2. Several key assumptions were made concerning NO_x and SO_2 emissions; these are discussed below.

Emission estimates for the toxic air pollutant nitric oxide (NO), a component of NO_x, are based on the assumption that 95 percent of the NO_x emitted from a turbine is in the form of NO. Therefore, as NOx emissions are reduced, nitric oxide emissions also are reduced.

SO_2 emissions were based on an estimated maximum annual concentration of 200 parts per million (ppm) of H_2S in the digester gas stream because this is the concentration typically seen in the digester gas at the King County South Wastewater Treatment Plant.

Fuel Cells

It is possible that the final design of the Brightwater Treatment Plant would use fuel cells instead of turbines for converting the digester gas into energy. Emissions from fuel cells consist mostly of nitrogen, water vapor, and carbon dioxide. Fuel cells do generate some emissions of NO_x, CO, and VOCs, but at significantly lower levels than combustion technology like the cogen turbines. A 1.0-megawatt (MW) fuel cell is currently being installed at the South Wastewater Treatment Plant. The fuel cell will be tested on both digester gas and natural gas during a 2-year demonstration period from fall 2003 through fall 2005. Air emissions will be monitored during this period, and the data from the demonstration will be used to determine future feasibility for long-term use of fuel cells at wastewater treatment plants, including Brightwater.

Diesel-Fired Standby Internal Combustion Engine

This air emissions analysis includes the use of two 250-kilowatt (kW) standby internal combustion (IC) engines to provide emergency power to serve essential life and safety needs and to startup the cogens during a power failure. These standby IC engines would only be used as an emergency source of power. This analysis assumes that the engines could be operated for up to 500 hours per year, or 6 percent of the year, in a standby mode. It was assumed that the standby IC engines, when operated, would be operated at greater than 90 percent capacity. Emission factors for these types of units are provided in Section 3.3 of AP-42.

The engines were assumed to meet Tier 2 emission standards for NOx, hydrocarbons, CO, and particulate matter as specified in 40 CFR Chapter I Part 89 for off-highway IC engines. If they are built after 2006, they would likely have to meet the Tier 3 emission standards in 40 CFR Chapter 1, Part 89. The Tier 3 emission standards are more stringent than the Tier 2 standards. As in the cogen discussion, emission estimates for the toxic air pollutant NO are based on the assumption that 95 percent of the NO_x emitted from a engines would be in the form of NO.

The standby engines and the cogen turbines do not operate at the same time. Therefore, yearly and daily potential emission estimates for each pollutant were estimated assuming that the process with the highest emission rate for that pollutant is operating the maximum amount of time allowed.

Enclosed Flare

The digester gas flared would be the peak digester gas production of 1,100 cfm for a 54 mgd facility and 1,600 cfm for a 72 mgd facility. AP-42 does not include specific emission factors for digester gas flares, so the emission factors for industrial flares (from

Section 13.5 of AP-42) were used. SO_2 emissions are based on an estimated maximum annual concentration of 200 ppm of hydrogen sulfide in the digester gas stream.

AP-42 does not provide emission factors for TAP and HAP emissions from enclosed flares. However, because the flare would not operate at the same time as the cogens, and because the flare only combusts a maximum of 1,100 cfm of digester gas (39.6 million Btu per hour (MMBtu/hr)) while the cogens combust 84 MMBtu/hr for a 54 mgd facility, it was assumed that the cogens would provide higher daily emission rates for toxics. Therefore, the toxic emissions from combustion of digester gas were modeled from the cogens instead of the flares. The ambient impacts are not only a function of emission rate, but also a function of stack location and stack parameters such as height and temperature of the exhaust. The cogens were located closer to the fence line than the flare, which creates less dilution time for the plume.

A regenerative thermal oxidizer (RTO) may be used instead of a flare. It is more conservative to use flare emissions because they are generally higher.

Natural Gas-Fired Hot Water Heaters

The 54-mgd treatment plant would require three 250-horsepower boilers (8.3 MMBtu/hr heat input) to provide adequate heat for the buildings during winter months. The 72-mgd treatment plant would require four 250-horsepower boilers. Emission factors for these units are provided in AP-42 Section 1.4, and the factors for small boilers (less than 100 MMBtu/hr output capacity) were used, with low-NO_x burners assumed to be installed.

Route 9. Criteria pollutant, TAP, and HAP emissions were estimated based on the maximum design capacity of the equipment installed (Tables 26 and 27). The emissions were estimated for the project design capacity of 54 mgd. Lead is both a criteria pollutant and a TAP, but is only presented here for TAPs.

TABLE 26
Summary of Potential Criteria Pollutant Emissions from Combustion Sources at Route 9 Site

Pollutant	Route 9 at 54 mgd (tons per year)
Nitrogen oxides	36
Carbon monoxide	48
Particulate matter < 10 microns	5
Particulate matter < 2.5 microns	5
Sulfur dioxide	6
Volatile organic compounds	2

TABLE 27
Summary of Hazardous and Toxic Air Pollutants (HAP and TAP) Emissions from Combustion Sources at Route 9 Site

Pollutant	Route 9 at 54 mgd (pounds per year)
2-Methylnaphthalene	0.0034
Acetaldehyde	56
Acrolein	8.7
Arsenic	0.029
Barium	0.63
Benzene	17.5
Butane	299
Cadmium	0.157
Chlorobenzene	0.009
Chloroform	0.019
Chromium	0.200
Dichlorobenzene	0.196
Dichloroethane	0.034
Ethylbenzene	40
Fluoranthene	0.0004
Fluorene	0.0004
Formaldehyde	916
Hexane	257
Lead	0.071
Manganese	0.054
Mercury	0.037
Methylene chloride	0.006
Molybdenum	0.157
Naphthalene	2.1
Nitric oxide	67789
PAH	3
Pentane	371
Phenanthrene	0.0024
Pyrene	0.0007
Selenium	1.4
Tetrachloroethylene (perchloroethylene)	0.09

TABLE 27
Summary of Hazardous and Toxic Air Pollutants (HAP and TAP) Emissions from Combustion Sources at Route 9 Site

Pollutant	Route 9 at 54 mgd (pounds per year)
Toluene	162
Trichloroethane	0.0007
Vanadium	0.33
Vinyl chloride	0.034
Xylene	80
Zinc	4.1

Unocal. Criteria pollutant, TAP, and HAP emissions were estimated based on the maximum design capacity of the equipment installed (Tables 28 and 29). The emissions were estimated for the project design capacity of 54 mgd and 72 mgd. Lead is both a criteria and a toxic air pollutant, but is only presented in the table for toxic air pollutants.

Plantwide Emissions

Hydrogen sulfide and ammonia were evaluated as odor-causing compounds; however, they are also considered toxic air contaminants. Therefore, they have been included in the plantwide emission of toxic and hazardous air pollutants. The estimated emissions for hydrogen sulfide and ammonia are from the calculations described in Section 4.5.2, Assumed Odor Concentrations, and not from BASTE.

TABLE 28
Summary of Potential Criteria Pollutant Emissions from Combustion Sources at Unocal Site

Pollutant	Unocal at 54 mgd (Tons Per Year)	Unocal at 72 mgd (Tons Per Year)
Nitrogen oxides	36	44
Carbon monoxide	48	60
Particulate matter < 10 microns	5	7
Particulate matter < 2.5 microns	5	7
Sulfur dioxide	6	8
Volatile organic compounds	2	3

TABLE 29
Summary of Hazardous and Toxic Air Pollutants (HAP and TAP) Emissions from Combustion Sources at Unocal Site

Pollutant	Unocal at 54 mgd (pounds per year)	Unocal at 72 mgd (pounds per year)
2-Methylnaphthalene	0.0034	0.0046
Acetaldehyde	56	69
Acrolein	8.7	10.8
Arsenic	0.029	0.038
Barium	0.63	0.84
Benzene	17.5	20.9
Butane	299	399
Cadmium	0.157	0.209
Chlorobenzene	0.009	0.012
Chloroform	0.019	0.026
Chromium	0.200	0.266
Dichlorobenzene	0.196	0.262
Dichloroethane	0.034	0.045
Ethylbenzene	40	49
Fluoranthene	0.0004	0.0006
Fluorene	0.0004	0.0005
Formaldehyde	916	1122
Hexane	257	342
Lead	0.071	0.095
Manganese	0.054	0.072
Mercury	0.037	0.049
Methylene chloride	0.006	0.008
Molybdenum	0.157	0.209
Naphthalene	2.1	2.5
Nitric oxide	67789	84127
PAH	3	4
Pentane	371	494
Phenanthrene	0.0024	0.0032
Pyrene	0.0007	0.0010
Selenium	1.4	1.8
Tetrachloroethylene (perchloroethylene)	0.09	0.12

TABLE 29
Summary of Hazardous and Toxic Air Pollutants (HAP and TAP) Emissions from Combustion Sources at Unocal Site

Pollutant	Unocal at 54 mgd (pounds per year)	Unocal at 72 mgd (pounds per year)
Toluene	162	198
Trichloroethane	0.0007	0.0010
Vanadium	0.33	0.44
Vinyl chloride	0.034	0.045
Xylene	80	98
Zinc	4.1	5.5

Route 9. The plantwide emissions for the Route 9 site are summarized in Tables 30 and 31.

TABLE 30
Summary of Plantwide Potential Criteria Pollutant Emissions at Route 9 Site

Pollutant	Route 9 at 54 mgd (tons per year)
Nitrogen oxides	36
Carbon monoxide	48
Particulate matter < 10 microns	5
Particulate matter < 2.5 microns	5
Sulfur dioxide	6
Volatile organic compounds	5

TABLE 31
Summary of Plantwide Hazardous and Toxic Air Pollutants (HAP and TAP) Emissions at Route 9 Site

Pollutant	Class A or B TAP	HAP	54 mgd (Pounds per Year)
2-Methylnaphthalene	Federal PAH	Yes	0.0034
Acetaldehyde	A		56
Acrolein	B		8.7
Acrylonitrile	A	Yes	4.8
Ammonia	B		39.7
Arsenic	A		0.029
Barium	B		0.63

TABLE 31
Summary of Plantwide Hazardous and Toxic Air Pollutants (HAP and TAP) Emissions at Route 9 Site

Pollutant	Class A or B TAP	HAP	54 mgd (Pounds per Year)
Benzene	A		119
Butane	B		299
Cadmium	A		0.16
Carbon tetrachloride	A	Yes	16
Chlorobenzene	B	Yes	92
Chloroform	A	Yes	961
Chromium	B		0.200
Dichlorobenzene	A		158
Dichloroethane	A		0.034
Ethylbenzene	B		126
Ethylene dibromide	A	Yes	3.3
Fluoranthene	Federal PAH	Yes	0.0004
Fluorene	Federal PAH	Yes	0.0004
Formaldehyde	A		916
Hexane	B		257
Hydrogen Sulfide	B		8.5
Lead	A		0.071
Manganese	B		0.054
Mercury	B		0.037
Methylene chloride	A	Yes	205
Methyl chloroform (1,1,1 Trichloroethane)	B	Yes	693
Molybdenum	B		0.157
Naphthalene	B		2.1
Nitric oxide	B		67,789
PAH	A - TAP PAH		3.0
Pentane	B		371
Phenanthrene	Federal PAH	Yes	0.0024
Pyrene	Federal PAH	Yes	0.0007
Selenium	B		1.4
Styrene	B	Yes	29
Tetrachloroethylene	A	Yes	1401

TABLE 31
Summary of Plantwide Hazardous and Toxic Air Pollutants (HAP and TAP) Emissions at Route 9 Site

Pollutant	Class A or B TAP	HAP	54 mgd (Pounds per Year)
(perchloroethylene)			
Toluene	B		669
Trichloroethane	B		0.0007
Trichloroethylene	A	Yes	135
Vanadium	B		0.33
Vinyl chloride	A	Yes	3.3
Vinylidene chloride	B	Yes	41
Xylene	B		697
Zinc	B		4.1
Total HAPs			**5,738**
Total TAPs without Nitric Oxide			**7,322**
Total TAPs with Nitric Oxide			**75,111**

PAH = polycyclic aromatic hydrocarbon

Unocal. The plantwide emissions for the Unocal site are summarized in Tables 32 and 33.

TABLE 32
Summary of Plantwide Potential Criteria Pollutant Emissions at Unocal Site

Pollutant	Unocal at 54 mgd (tons per year)	Unocal at 72 mgd (tons per year)
Nitrogen oxides	36	44
Carbon monoxide	48	60
Particulate matter < 10 microns	5	7
Particulate matter < 2.5 microns	5	7
Sulfur dioxide	6	8
Volatile organic compounds	5	6

TABLE 33
Summary of Plantwide Hazardous and Toxic Air Pollutants (HAP and TAP) Emissions at Unocal Site

Pollutant	Class A or B TAP	HAP	54 mgd (pounds per year)	72 mgd (pounds per year)
2-Methylnaphthalene	Federal PAH	Yes	0.0034	0.0046
Acetaldehyde	A		56	69
Acrolein	B		8.7	10.8
Acrylonitrile	A	Yes	4.8	6.3
Ammonia	B		39.7	52.5
Arsenic	A		0.029	0.038
Barium	B		0.63	0.84
Benzene	A		119	147
Butane	B		299	399
Cadmium	A		0.16	0.21
Carbon tetrachloride	A	Yes	16	22
Chlorobenzene	B	Yes	92	114
Chloroform	A	Yes	961	1283
Chromium	B		0.200	0.266
Dichlorobenzene	A		158	195
Dichloroethane	A		0.034	0.045
Ethylbenzene	B		126	156
Ethylene dibromide	A	Yes	3.3	4.4
Fluoranthene	Federal PAH	Yes	0.0004	0.0006
Fluorene	Federal PAH	Yes	0.0004	0.0005
Formaldehyde	A		916	1122
Hexane	B		257	342
Hydrogen Sulfide	B		8.5	11.1
Lead	A		0.071	0.095
Manganese	B		0.054	0.072
Mercury	B		0.037	0.049
Methylene chloride	A	Yes	205	273
Methyl chloroform (1,1,1 Trichloroethane)	B	Yes	693	925
Molybdenum	B		0.157	0.209
Naphthalene	B		2.1	2.5
Nitric oxide	B		67,789	84,127

TABLE 33
Summary of Plantwide Hazardous and Toxic Air Pollutants (HAP and TAP) Emissions at Unocal Site

Pollutant	Class A or B TAP	HAP	54 mgd (pounds per year)	72 mgd (pounds per year)
PAH	A - TAP PAH		3.0	3.7
Pentane	B		371	494
Phenanthrene	Federal PAH	Yes	0.0024	0.0032
Pyrene	Federal PAH	Yes	0.0007	0.0010
Selenium	B		1.4	1.8
Styrene	B	Yes	29	36
Tetrachloroethylene (perchloroethylene)	A	Yes	1401	1871
Toluene	B		669	827
Trichloroethane	B		0.0007	0.0010
Trichloroethylene	A	Yes	135	179
Vanadium	B		0.33	0.44
Vinyl chloride	A	Yes	3.3	4.4
Vinylidene chloride	B	Yes	41	55
Xylene	B		697	862
Zinc	B		4.1	5.5
Total HAPs			**5,738**	**7,447**
Total TAPs without Nitric Oxide			**7,322**	**9,478**
Total TAPs with Nitric Oxide			**75,111**	**93,605**

PAH = polycyclic aromatic hydrocarbon

Offsite Air Quality Impacts

The results of the air quality modeling at both sites indicate that predicted impacts using onsite meteorological data and Paine Field data would not result in any ASIL exceedances beyond the property line of the treatment plant except for chloroform. For Tables 34 through 38, the maximum impacts of the combined onsite and Paine Field data set are shown. An evaluation of the removal efficiency of the carbon, and its feasibility as a control device for chloroform, is currently being conducted. If it is not technically feasible to control chloroform using carbon or some other control technology to levels that meet the ASIL, then a second-tier analysis would be conducted. Chloroform emissions are regularly above the ASILs at other similar-sized wastewater treatment plants due to the chlorine in the drinking water that is discharged to the treatment plant. It is common to do a second-tier analysis, and typically the health impact assessment shows little to no health risks due to chloroform in the area surrounding a wastewater treatment plant.

A second-tier analysis was conducted for King County's West Point Sewage Treatment Plant in 1982. The analysis concluded that the exposure of Fort Lawton residents to the chloroform emissions from the West Point plant yielded an estimated cancer risk that was well below the generally accepted cancer risk of one in one million.

A second-tier analysis is an optional procedure to use after TBACT, and uses a health impact assessment instead of ASIL. Following EPA approved methods, risks could be more accurately characterized by using updated EPA unit risk factors, inhalation reference concentrations, or other EPA-recognized approved methods. A second-tier analysis includes a discussion of the demographics pertinent to assessing the public health risk, a brief review of the toxicological literature regarding chloroform, characterization of existing emissions and exposure pathways, and a quantitative estimate of the cancer risk to potentially exposed individuals.

The tables below present the maximum predicted concentration of each TAP in the ambient air in micrograms per cubic meter (ug/m^3) at or beyond the fence line of the treatment plant. The tables also present the ASIL for comparison. The maximum predicted concentration is from the combined onsite and Paine Field data set, as described in Section 3 in the subsection titled Meteorological Data.

Route 9

The results of the dispersion modeling for the 54-mgd treatment plant at Route 9, shown in Table 34, indicate that a treatment plant at the Route 9 site would not exceed the ASIL for any of the pollutants modeled except chloroform.

TABLE 34
Dispersion Modeling Results for a 54-mgd Treatment Plant at Route 9 Site

Pollutant	ASIL (µg/m^3)	Averaging Period	Maximum Predicted Concentration (µg/m^3)
Acetaldehyde	0.45	Annual	0.003
Acrolein	0.02	24 hour	0.002
Arsenic	0.00023	Annual	0.00003
Benzene	0.12	Annual	0.05
Cadmium	0.00056	Annual	0.0002
Chloroform	0.043	Annual	0.32
Chromium	1.7	24 hour	0.0009
Ethylene dibromide	0.0045	Annual	0.0015
Formaldehyde	0.077	Annual	0.04
Methylene Chloride	0.56	Annual	0.09
Methyl chloroform (1,1,1 Trichloroethane)	6400	24 hour	2.12
Nitric Oxide	100	24 hour	29.92
Total TAP PAH	0.00048	Annual	0.00013

TABLE 34
Dispersion Modeling Results for a 54-mgd Treatment Plant at Route 9 Site

Pollutant	ASIL ($\mu g/m^3$)	Averaging Period	Maximum Predicted Concentration ($\mu g/m^3$)
Tetrachloroethylene (perchloroethylene)	1.1	Annual	0.65
Trichloroethylene	0.59	Annual	0.06
Xylene	1500	24 hour	2.19
Lead	0.5	24 hour	0.0003

PAH = polycyclic aromatic hydrocarbon
$\mu g/m^3$ = microgram per cubic meter

Unocal

54-mgd Plant. The results of the dispersion modeling for the 54-mgd treatment plant, shown in Table 35, indicate that a treatment plant at the Unocal site would not exceed the ASIL for any of the pollutants modeled except chloroform.

TABLE 35
Dispersion Modeling Results for a 54-mgd Treatment Plant at Unocal Site

Pollutant	ASIL ($\mu g/m^3$)	Averaging Period	Maximum Predicted Concentration ($\mu g/m^3$)
Acetaldehyde	0.45	Annual	0.00008
Acrolein	0.02	24 hour	0.001
Arsenic	0.00023	Annual	0.00001
Benzene	0.12	Annual	0.03
Cadmium	0.00056	Annual	0.00007
Chloroform	0.043	Annual	0.29
Chromium	1.7	24 hour	0.001
Ethylene dibromide	0.0045	Annual	0.001
Formaldehyde	0.077	Annual	0.01
Methylene Chloride	0.56	Annual	0.06
Methyl chloroform (1,1,1 Trichloroethane)	6400	24 hour	4.48
Nitric Oxide	100	24 hour	37.75
Total TAP PAH	0.00048	Annual	0.00003
Tetrachloroethylene (perchloroethylene)	1.1	Annual	0.43

TABLE 35
Dispersion Modeling Results for a 54-mgd Treatment Plant at Unocal Site

Pollutant	ASIL ($\mu g/m^3$)	Averaging Period	Maximum Predicted Concentration ($\mu g/m^3$)
Trichloroethylene	0.59	Annual	0.041
Xylene	1500	24 hour	3.93
Lead	0.5	24 hour	0.0004

PAH = polycyclic aromatic hydrocarbon
$\mu g/m^3$ = microgram per cubic meter

54-mgd Treatment Plant with Structural Lid Sub-Alternative

Dispersion modeling was also conducted for the Unocal Structural Lid sub-alternative. The results are summarized in Table 36.

The results of the dispersion modeling for a 54-mgd treatment plant with a lid over a portion of the plant demonstrated that all the compounds except chloroform are predicted to have ambient impacts less than the ASIL.

TABLE 36
Dispersion Modeling Results for a 54-mgd Treatment Plant at Unocal Site with Structural Lid

Pollutant	ASIL ($\mu g/m^3$)	Averaging Period	Maximum Predicted Concentration ($\mu g/m^3$)
Acetaldehyde	0.45	Annual	0.0006
Acrolein	0.02	24 hour	0.0010
Arsenic	0.00023	Annual	0.00001
Benzene	0.12	Annual	0.04
Cadmium	0.00056	Annual	0.00007
Chloroform	0.043	Annual	0.36
Chromium	1.7	24 hour	0.001
Ethylene dibromide	0.0045	Annual	0.001
Formaldehyde	0.077	Annual	0.01
Methylene Chloride	0.56	Annual	0.08
Methyl chloroform (1,1,1 Trichloroethane)	6400	24 hour	7.85
Nitric Oxide	100	24 hour	37.75
Total TAP PAH	0.00048	Annual	0.00003
Tetrachloroethylene (perchloroethylene)	1.1	Annual	0.52
Trichloroethylene	0.59	Annual	0.05

TABLE 36
Dispersion Modeling Results for a 54-mgd Treatment Plant at Unocal Site with Structural Lid

Pollutant	ASIL ($\mu g/m^3$)	Averaging Period	Maximum Predicted Concentration ($\mu g/m^3$)
Xylene	1500	24 hour	6.91
Lead	0.5	24 hour	0.0004

PAH = polycyclic aromatic hydrocarbon
$\mu g/m^3$ = microgram per cubic meter

72-mgd Treatment Plant

The results of the dispersion modeling indicate that predicted concentrations from a 72-mgd treatment plant at the Unocal site do not exceed the ASIL for all compounds except chloroform. Results are summarized in Table 37.

TABLE 37
Dispersion Modeling Results for a 72-mgd Treatment Plant at Unocal Site

Pollutant	ASIL ($\mu g/m^3$)	Averaging Period	Maximum Predicted Concentration ($\mu g/m^3$)
Acetaldehyde	0.45	Annual	0.0007
Acrolein	0.02	24 hour	0.0009
Arsenic	0.00023	Annual	0.00002
Benzene	0.12	Annual	0.04
Cadmium	0.00056	Annual	0.00009
Chloroform	0.043	Annual	0.39
Chromium	1.7	24 hour	0.001
Ethylene dibromide	0.0045	Annual	0.001
Formaldehyde	0.077	Annual	0.01
Methylene Chloride	0.56	Annual	0.09
Methyl chloroform (1,1,1 Trichloroethane)	6400	24 hour	5.97
Nitric Oxide	100	24 hour	48.28
Total TAP PAH	0.00048	Annual	0.00004
Tetrachloroethylene (perchloroethylene)	1.1	Annual	0.59
Trichloroethylene	0.59	Annual	0.06
Xylene	1500	24 hour	4.87
Lead	0.5	24 hour	0.0005

PAH = polycyclic aromatic hydrocarbon
$\mu g/m^3$ = microgram per cubic meter

72-mgd Treatment Plant with a Structural Lid

The results of the dispersion modeling indicate that predicted concentrations from a 72-mgd treatment plant at the Unocal site with a structural lid do not exceed the ASIL for all compounds except chloroform. Results are summarized in Table 38.

TABLE 38
Dispersion Modeling Results for a 72-mgd Treatment Plant at Unocal Site with Structural Lid

Pollutant	ASIL ($\mu g/m^3$)	Averaging Period	Maximum Predicted Concentration ($\mu g/m^3$)
Acetaldehyde	0.45	Annual	0.0007
Acrolein	0.02	24 hour	0.0009
Arsenic	0.00023	Annual	0.00002
Benzene	0.12	Annual	0.05
Cadmium	0.00056	Annual	0.00009
Chloroform	0.043	Annual	0.47
Chromium	1.7	24 hour	0.001
Ethylene dibromide	0.0045	Annual	0.002
Formaldehyde	0.077	Annual	0.01
Methylene Chloride	0.56	Annual	0.1
Methyl chloroform (1,1,1 Trichloroethane)	6400	24 hour	7.89
Nitric Oxide	100	24 hour	48.28
Total TAP PAH	0.00048	Annual	0.00004
Tetrachloroethylene (perchloroethylene)	1.1	Annual	0.71
Trichloroethylene	0.59	Annual	0.07
Xylene	1500	24 hour	6.42
Lead	0.5	24 hour	0.0005

PAH = polycyclic aromatic hydrocarbon
$\mu g/m^3$ = microgram per cubic meter

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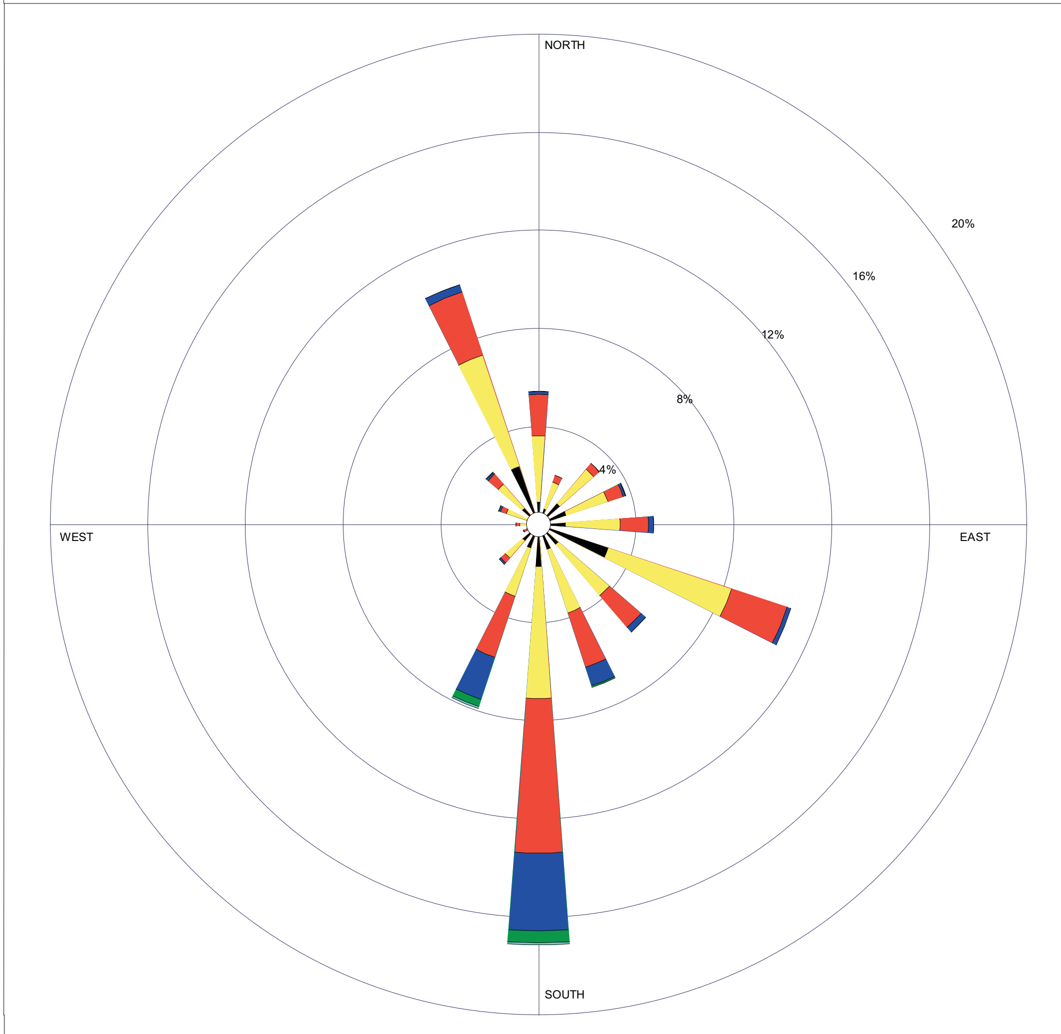
WIND ROSE PLOT

Station #24203 - Paine Field



Wind Speed (m/s)			
> 11.06 8.49 - 11.06 5.40 - 8.49 3.34 - 5.40 1.80 - 3.34 0.51 - 1.80	MODELER	DATE **12/5/2002**	COMPANY NAME
	DISPLAY **Wind Speed**	UNIT **m/s**	COMMENTS
	AVG. WIND SPEED **3.18 m/s**	WINDS <0.51 M/S **13.34%**	
	ORIENTATION **Direction (blowing from)**	PLOT YEAR-DATE-TIME **1961 1962 1964 1965** **Jan 1 - Dec 31** **Midnight - 11 PM**	PROJECT/PLOT NO.

WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com

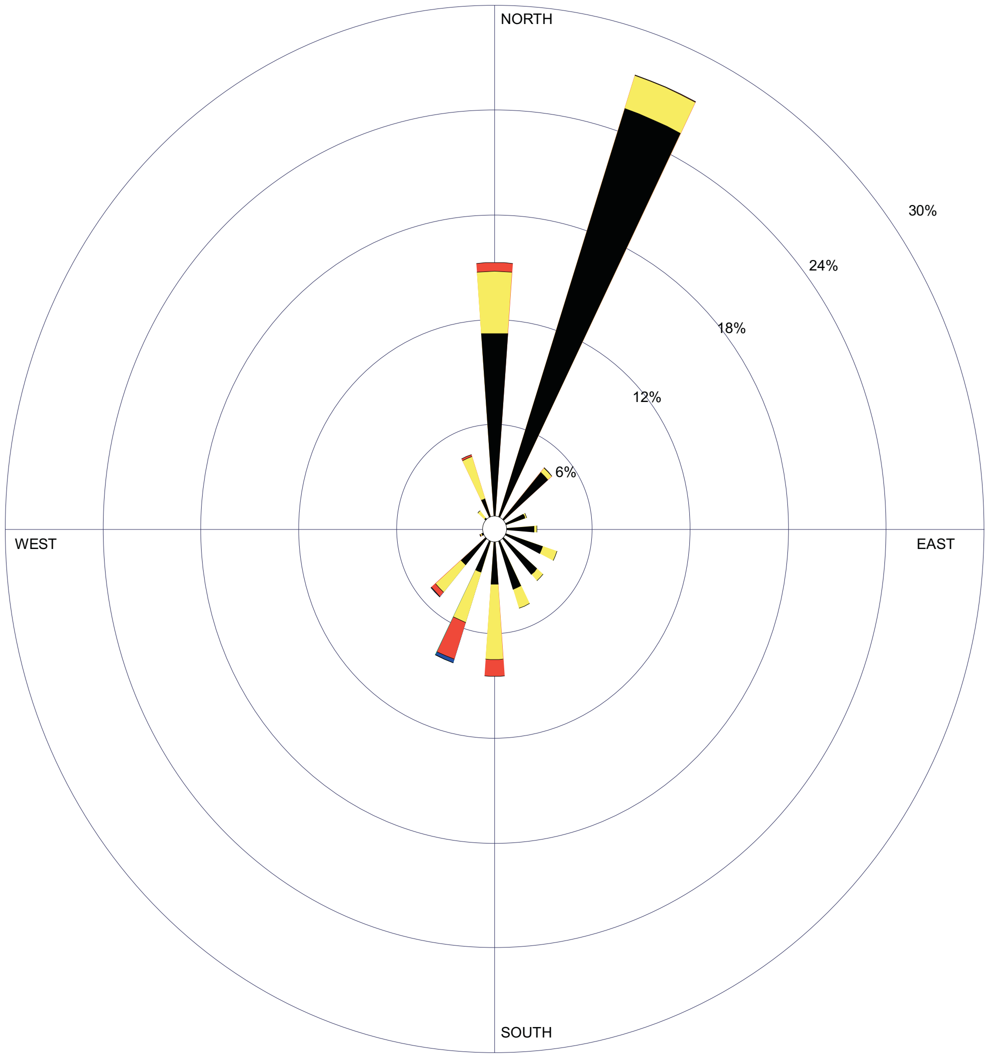
King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

Data Sources: WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com
File Name: 176493.03.06_W052003009SEA_Odor and Air Quality • Fig 1 Paine Field Meteorological Station • 10/30/03 • lw

Figure 1
Paine Field Meteorological Station
BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

WIND ROSE PLOT

Route 9 July 2002 - March 2003 Windrose



Wind Speed (m/s)			
> 11.06 8.49 - 11.06 5.40 - 8.49 3.34 - 5.40 1.80 - 3.34 0.51 - 1.80	MODELER	DATE **5/7/2003**	COMPANY NAME
	DISPLAY **Wind Speed**	UNIT **m/s**	COMMENTS
	AVG. WIND SPEED **1.56 m/s**	WINDS <0.51 M/S **5.63%**	
	ORIENTATION **Direction (blowing from)**	PLOT YEAR-DATE-TIME **2002-2003 Midnight - 11 PM**	PROJECT/PLOT NO.

WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com

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Department of
Natural Resources and Parks
Wastewater Treatment Division

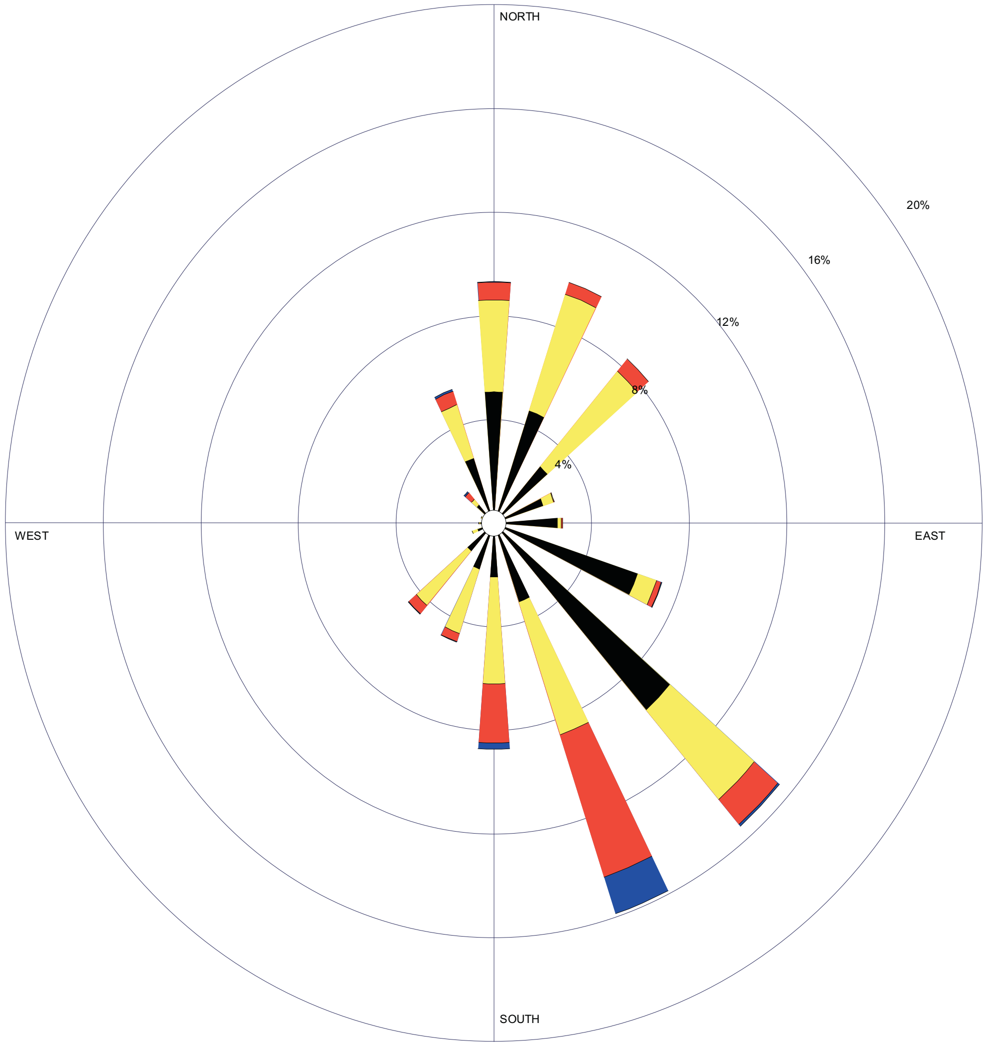
Data Sources: WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com
File Name: 176493.03.06_W052003009SEA_Odor and Air Quality • Fig 2 Route 9 Meteorological Station • 10/30/03 • lw

Figure 2
Route 9 Meteorological Station

BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

WIND ROSE

Unocal July 2002 - March 2003 Windrose



Wind Speed (m/s)	MODELER	DATE **5/7/2003**	COMPANY
> 11.06	DISPLAY **Wind Speed**	UNIT **m/s**	COMMENTS
8.49 - 11.06			
5.40 - 8.49	AVG. WIND **2.19 m/s**	WINDS <0.51 **1.19%**	
3.34 - 5.40			
1.80 - 3.34	ORIENTATION **Direction (blowing from)**	PLOT YEAR-DATE- **2002-2003 Midnight – 11 pm**	PROJECT/PLOT
0.51 - 1.80			

WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com

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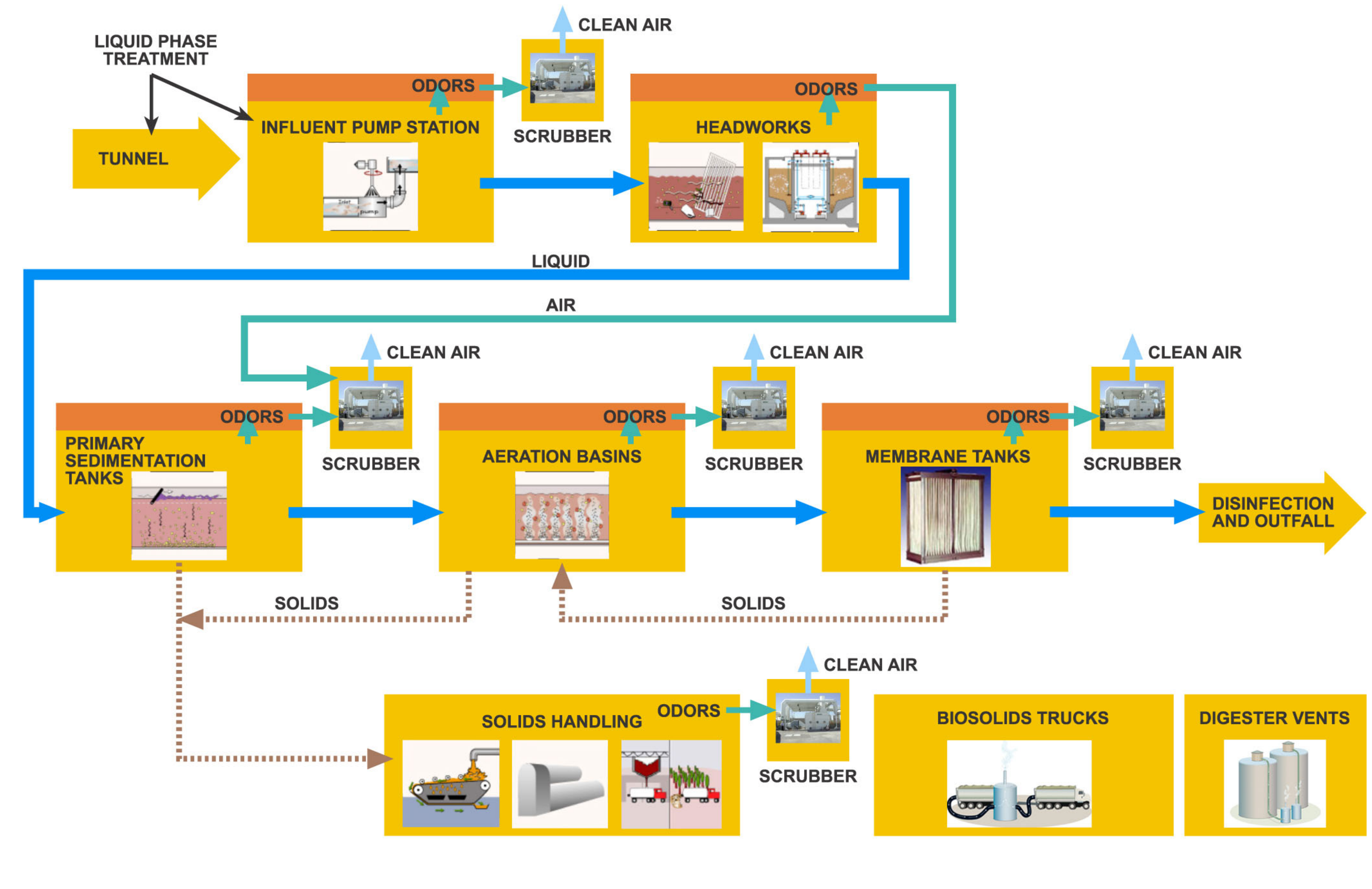
Department of
Natural Resources and Parks
Wastewater Treatment Division

Data Sources: WRPLOT View 3.5 by Lakes Environmental Software - www.lakes-environmental.com
File Name: 176493.03.06_W052003009SEA_Odor and Air Quality • Fig 3 Unocal Meteorological Station • 10/30/03 • lw

Figure 3
Unocal Meteorological Station

BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM



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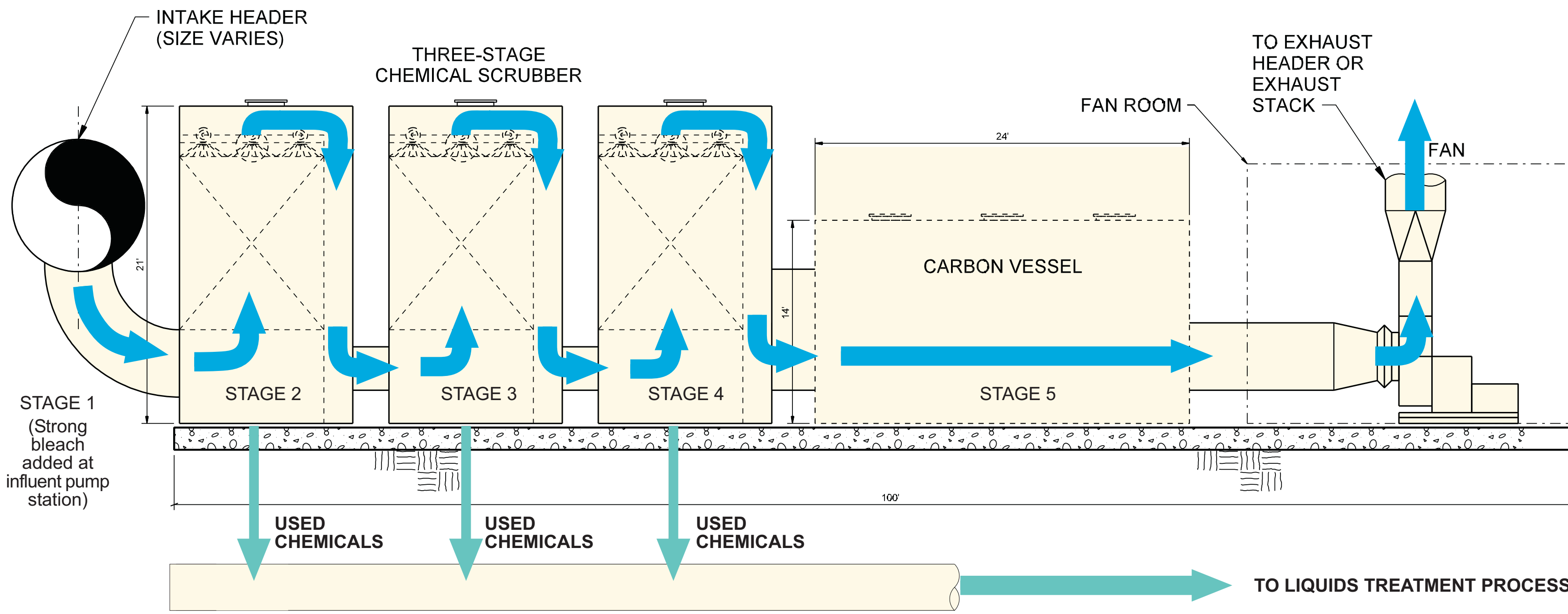
Wastewater Treatment Division

Data Source: CH2M HILL
File Name: 176493.03.06_W052003009SEA_Odor and Air Quality • Fig 4 Process Flow Schematic • 10/31/03 • lw/gr/lw

Figure 4
Process Flow Schematic Showing Odor Prevention Systems

BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

Brightwater Odor Treatment



Five Stages of Odor Treatment

Stage 1: Strong bleach added to liquid wastewater

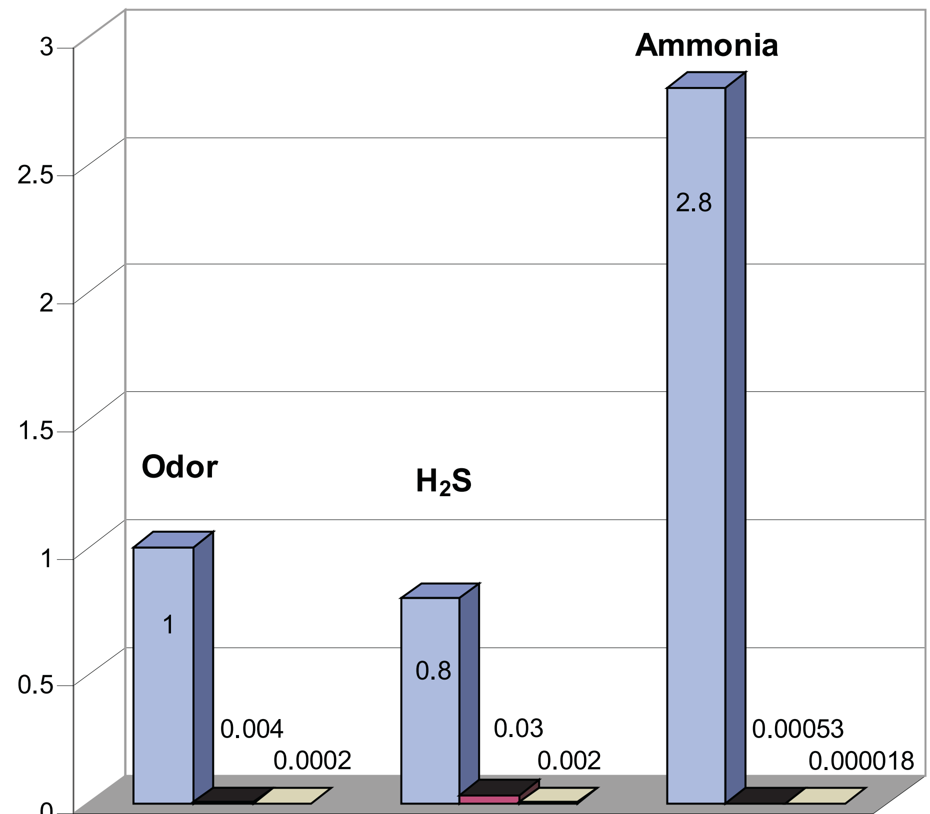
Stages 2-4: Three stages of chemical scrubbing

Stage 5: Final stage – carbon polishing

Figure 5

Conceptual Odor Prevention Scrubber

BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM



	Odor (D/T)	H2S (ppbV)	Ammonia (ppmV)
Detection Threshold	1	0.8	2.8
Max Off-Site Concentration	0.004	0.03	0.00053
Average Off-Site Concentration	0.0002	0.002	0.000018

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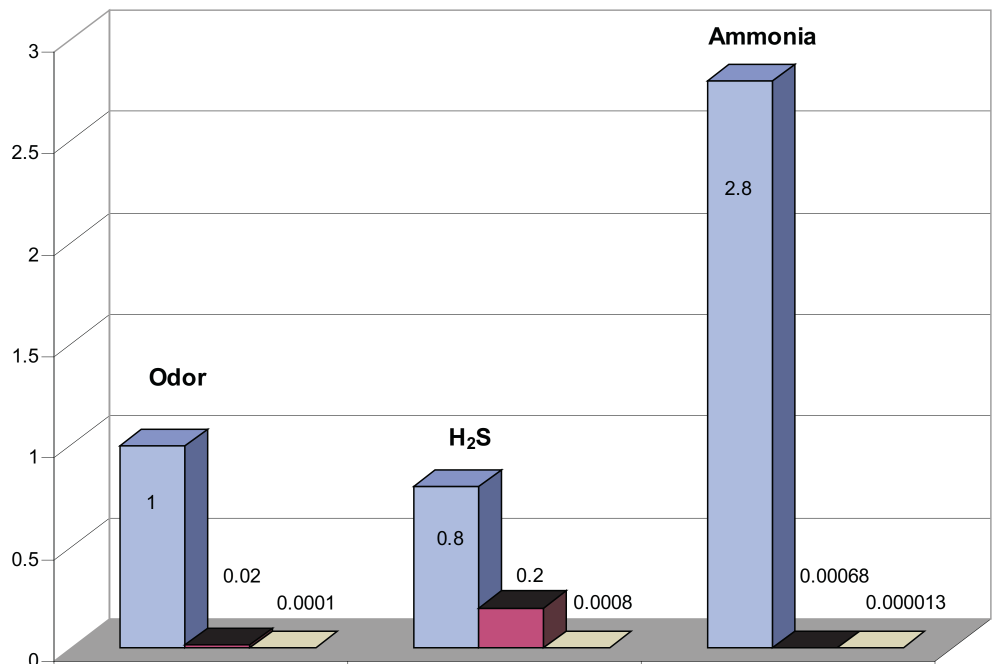
Data Source: CH2M HILL
File Name: 176493.03.06_W052003009SEA_Odor and Air Quality • Fig 6 Comparison of Detection Threshold_Route 9 • 10/30/03 • lw

Figure 6

Comparison of Detection Threshold, Maximum, and Average Off-Site Concentrations at Route 9 (36 mgd) using On-Site Meteorological Data



	Odor (D/T)	H2S (ppbV)	Ammonia (ppmV)
Approximate Detection Threshold	1	0.8	2.8
Max Off-Site Concentration	0.02	0.2	0.00068
Average Off-Site Concentration	0.0001	0.0008	0.000013

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Natural Resources and Parks
Wastewater Treatment Division

Data Source: CH2M HILL
File Name: 176493.03.06_W052003009SEA_Odor and Air Quality • Fig 7 Comparison of Detection Threshold_Unocal • 10/30/03 • lw

Figure 7

Comparison of Detection Threshold, Maximum, and Average Off-Site Concentrations at Unocal (36 mgd) using On-Site Meteorological Data

ATTACHMENTS

- A – Hazardous Air Pollutants
- B – Toxic Air Pollutants
- C – Substances Requiring Risk Management Plans
- D – Influent Concentrations used in Air Toxics Emission Modeling
- E – Combustion Source Parameters
- F – Liquids and Solids Source Parameters
- G – Acronyms and Abbreviations

ATTACHMENT A – Hazardous Air Pollutants

ATTACHMENT A – Hazardous Air Pollutants

http://www.epa.gov/ttn/atw/188polls.html

CAS Number	Chemical Name
75070	Acetaldehyde
60355	Acetamide
75058	Acetonitrile
98862	Acetophenone
53963	2-Acetylaminofluorene
107028	Acrolein
79061	Acrylamide
79107	Acrylic acid
107131	Acrylonitrile
107051	Allyl chloride
92671	4-Aminobiphenyl
62533	Aniline
90040	o-Anisidine
1332214	Asbestos
71432	Benzene (including benzene from gasoline)
92875	Benzidine
98077	Benzotrichloride
100447	Benzyl chloride
92524	Biphenyl
117817	Bis(2-ethylhexyl)phthalate (DEHP)
542881	Bis(chloromethyl)ether
75252	Bromoform
106990	1,3-Butadiene
156627	Calcium cyanamide
105602	Caprolactam (See Modification)
133062	Captan
63252	Carbaryl
75150	Carbon disulfide
56235	Carbon tetrachloride
463581	Carbonyl sulfide
120809	Catechol
133904	Chloramben
57749	Chlordane
7782505	Chlorine
79118	Chloroacetic acid
532274	2-Chloroacetophenone
108907	Chlorobenzene
510156	Chlorobenzilate
67663	Chloroform
107302	Chloromethyl methyl ether
126998	Chloroprene
1319773	Cresols/Cresylic acid (isomers and mixture)
95487	o-Cresol
108394	m-Cresol
106445	p-Cresol
98828	Cumene
94757	2,4-D, salts and esters
3547044	DDE
334883	Diazomethane
132649	Dibenzofurans
96128	1,2-Dibromo-3-chloropropane
84742	Dibutylphthalate
106467	1,4-Dichlorobenzene(p)
91941	3,3-Dichlorobenzidene
111444	Dichloroethyl ether (Bis(2-chloroethyl)ether)

CAS Number	Chemical Name
542756	1,3-Dichloropropene
62737	Dichlorvos
111422	Diethanolamine
121697	N,N-Diethyl aniline (N,N-Dimethylaniline)
64675	Diethyl sulfate
119904	3,3-Dimethoxybenzidine
60117	Dimethyl aminoazobenzene
119937	3,3'-Dimethyl benzidine
79447	Dimethyl carbamoyl chloride
68122	Dimethyl formamide
57147	1,1-Dimethyl hydrazine
131113	Dimethyl phthalate
77781	Dimethyl sulfate
534521	4,6-Dinitro-o-cresol, and salts
51285	2,4-Dinitrophenol
121142	2,4-Dinitrotoluene
123911	1,4-Dioxane (1,4-Diethyleneoxide)
122667	1,2-Diphenylhydrazine
106898	Epichlorohydrin (l-Chloro-2,3-epoxypropane)
106887	1,2-Epoxybutane
140885	Ethyl acrylate
100414	Ethyl benzene
51796	Ethyl carbamate (Urethane)
75003	Ethyl chloride (Chloroethane)
106934	Ethylene dibromide (Dibromoethane)
107062	Ethylene dichloride (1,2-Dichloroethane)
107211	Ethylene glycol
151564	Ethylene imine (Aziridine)
75218	Ethylene oxide
96457	Ethylene thiourea
75343	Ethylidene dichloride (1,1-Dichloroethane)
50000	Formaldehyde
76448	Heptachlor
118741	Hexachlorobenzene
87683	Hexachlorobutadiene
77474	Hexachlorocyclopentadiene
67721	Hexachloroethane
822060	Hexamethylene-1,6-diisocyanate
680319	Hexamethylphosphoramide
110543	Hexane
302012	Hydrazine
7647010	Hydrochloric acid
7664393	Hydrogen fluoride (Hydrofluoric acid)
7783064	Hydrogen sulfide (See Modification)
123319	Hydroquinone
78591	Isophorone
58899	Lindane (all isomers)
108316	Maleic anhydride
67561	Methanol
72435	Methoxychlor
74839	Methyl bromide (Bromomethane)
74873	Methyl chloride (Chloromethane)
71556	Methyl chloroform (1,1,1-Trichloroethane)
78933	Methyl ethyl ketone (2-Butanone)
60344	Methyl hydrazine
74884	Methyl iodide (Iodomethane)
108101	Methyl isobutyl ketone (Hexone)
624839	Methyl isocyanate
80626	Methyl methacrylate
1634044	Methyl tert butyl ether
101144	4,4-Methylene bis(2-chloroaniline)

CAS Number	Chemical Name
75092	Methylene chloride (Dichloromethane)
101688	Methylene diphenyl diisocyanate (MDI)
101779	4,4¬-Methylenedianiline
91203	Naphthalene
98953	Nitrobenzene
92933	4-Nitrobiphenyl
100027	4-Nitrophenol
79469	2-Nitropropane
684935	N-Nitroso-N-methylurea
62759	N-Nitrosodimethylamine
59892	N-Nitrosomorpholine
56382	Parathion
82688	Pentachloronitrobenzene (Quintobenzene)
87865	Pentachlorophenol
108952	Phenol
106503	p-Phenylenediamine
75445	Phosgene
7803512	Phosphine
7723140	Phosphorus
85449	Phthalic anhydride
1336363	Polychlorinated biphenyls (Aroclors)
1120714	1,3-Propane sultone
57578	beta-Propiolactone
123386	Propionaldehyde
114261	Propoxur (Baygon)
78875	Propylene dichloride (1,2-Dichloropropane)
75569	Propylene oxide
75558	1,2-Propylenimine (2-Methyl aziridine)
91225	Quinoline
106514	Quinone
100425	Styrene
96093	Styrene oxide
1746016	2,3,7,8-Tetrachlorodibenzo-p-dioxin
79345	1,1,2,2-Tetrachloroethane
127184	Tetrachloroethylene (Perchloroethylene)
7550450	Titanium tetrachloride
108883	Toluene
95807	2,4-Toluene diamine
584849	2,4-Toluene diisocyanate
95534	o-Toluidine
8001352	Toxaphene (chlorinated camphene)
120821	1,2,4-Trichlorobenzene
79005	1,1,2-Trichloroethane
79016	Trichloroethylene
95954	2,4,5-Trichlorophenol
88062	2,4,6-Trichlorophenol
121448	Triethylamine
1582098	Trifluralin
540841	2,2,4-Trimethylpentane
108054	Vinyl acetate
593602	Vinyl bromide
75014	Vinyl chloride
75354	Vinylidene chloride (1,1-Dichloroethylene)
1330207	Xylenes (isomers and mixture)
95476	o-Xylenes
108383	m-Xylenes
106423	p-Xylenes
0	Antimony Compounds
0	Arsenic Compounds (inorganic including arsine)
0	Beryllium Compounds
0	Cadmium Compounds

CAS Number	Chemical Name
0	Chromium Compounds
0	Cobalt Compounds
0	Coke Oven Emissions
0	Cyanide Compounds[a]
0	Glycol ethers[b]
0	Lead Compounds
0	Manganese Compounds
0	Mercury Compounds
0	Fine mineral fibers[c]
0	Nickel Compounds
0	Polycylic Organic Matter[d]
0	Radionuclides (including radon)[e]
0	Selenium Compounds

NOTE: For all listings above that contain the word “compounds,” and for glycol ethers, the following applies: Unless otherwise specified, these listings are defined as including any unique chemical substance that contains the named chemical (i.e., antimony, arsenic, etc.) as part of that chemical's infrastructure.

[a] X'CN where X = H' or any other group where a formal dissociation may occur. For example, KCN or Ca(CN)2.

[b] Includes mono- and di- ethers of ethylene glycol, diethylene glycol, and triethylene glycol R-(OCH2CH2)n -OR' where
n = 1, 2, or 3
R = alkyl or aryl groups
R' = R, H, or groups which, when removed, yield glycol ethers with the structure: R-(OCH2CH)n-OH. Polymers are excluded from the glycol category.

[c] Includes mineral fiber emissions from facilities manufacturing or processing glass, rock, or slag fibers (or other mineral derived fibers) of average diameter 1 micron or less.

[d] Includes organic compounds with more than one benzene ring, and that have a boiling point greater than or equal to 100 °C.

[e] A type of atom that spontaneously undergoes radioactive decay.

ATTACHMENT B – Toxic Air Pollutants

ATTACHMENT B – Toxic Air Pollutants

WAC 173-460-150 Class A toxic air pollutants: Known, probable, and potential human carcinogens and acceptable source impact levels.

http://search.leg.wa.gov/wslwac/WAC%20173%20%20TITLE/WAC%20173%20-460%20%20CHAPTER/WAC%20173%20-460%20-150.htm

(1) TABLE I
CLASS A TOXIC AIR POLLUTANTS
Known and Probable Carcinogens

CAS #	SUBSTANCE
75-07-0	Acetaldehyde
53-96-3	2-Acetylaminofluorene
79-06-1	Acrylamide
107-13-1	Acrylonitrile
309-00-2	Aldrin
——	Aluminum smelter polyaromatic hydrocarbon emissions
117-79-3	2-Aminoanthraquinone
97-56-3	o-Aminoazotoluene
92-67-1	4-Aminobiphenyl
61-82-5	Amitrole
62-53-3	Aniline
90-04-0	o-Anisidine
C7440-38-2	Arsenic and inorganic arsenic compounds
1332-21-4	Asbestos
2465-27-2	Auramine (technical grade)
71-43-2	Benzene
92-87-5	Benzidine and its salts
56-55-3	Benzo(a)anthracene
50-32-8	Benzo(a)pyrene
205-99-2	Benzo(b)fluoranthene
205-82-3	Benzo(j)fluoranthene
207-08-9	Benzo(k)fluoranthene
1694-09-3	Benzyl violet 4b
7440-41-7	Beryllium and compounds
111-44-4	Bis(2-chloroethyl)ether
117-81-7	Bis(2-ethylhexyl)phthalate (DEHP)
542-88-1	Bis(chloromethyl)ether
75-25-2	Bromoform
106-99-0	1,3-Butadiene
3068-88-0	B-Butyrolactone
7440-43-9	Cadmium and compounds
56-23-5	Carbon tetrachloride
57-74-9	Chlordane
510-15-6	Chlorobenzilate
67-66-3	Chloroform
107-30-2	Chloromethyl methyl ether (technical-grade)
108-43-0	Chlorophenols
126-99-8	Chloroprene
C7440-47-3	Chromium, hexavalent metal and compounds
——	Coke oven emissions
8001-58-9	Creosote
135-20-6	Cupferron
94-75-7	2,4-D and esters
3547-04-4	DDE (p,p'-Dichlorodiphenyldichloroethylene)
50-29-3	DDT (1,1,1 Trichloro-2,2-Bis(p-chlorophenyl)-ethane)
613-35-4	N,N-Diacetylbenzidine
101-80-4	4,4'-Diaminodiphenyl ether

CAS #	SUBSTANCE
226-36-8	Dibenz(a,h)acridine
53-70-3	Dibenz(a,h)anthracene
224-42-0	Dibenz(a,j)acridine
132-64-9	Dibenzofurans
189-64-0	Dibenzo(a,h)pyrene
191-30-0	Dibenzo(a,l)pyrene
189-55-9	1,2,7,8-Dibenzopyrene (dibenzo(a,i)pyrene)
192-65-4	Dibenzo(a,e)pyrene
764-41-0	1,4-Dichloro-2-butene
28434-86-8	3,3'-Dichloro-4,4'-diaminodiphenyl ether
106-46-7	1,4-Dichlorobenzene
91-94-1	3,3'-Dichlorobenzidine
107-06-2	1,2-Dichloroethane (ethylene chloride)
75-09-2	Dichloromethane (methylene chloride)
696-28-6	Dichlorophenylarsine (arsenic group)
78-87-5	1,2-Dichloropropane
60-57-1	Dieldrin
1615-80-1	1,2-Diethylhydrazine
101-90-6	Diglycidyl resorcinol ether
119-90-4	3,3'-Dimethoxybenzidine (ortol-dianisidine)
119-93-7	3,3-Dimethyl benzidine
77-78-1	Dimethyl sulfate
540-73-8	1,2-Dimethylhydrazine
123-91-1	1,4-Dioxane
-----	Dioxins and furans
122-66-7	1,2-Diphenylhydrazine
106-89-8	Epichlorohydrin
106-93-4	Ethylene dibromide (dibromethane)
75-21-8	Ethylene oxide
96-45-7	Ethylene thiourea
50-00-0	Formaldehyde
67-45-8	Furazolidone
	Furium (nitrofuran group)
765-34-4	Glyciadaldehyde
76-44-8	Heptachlor
118-74-1	Hexachlorobenzene
319-84-6	Hexachlorocyclohexane (Lindane) Alpha BHC
319-85-7	Hexachlorocyclohexane (Lindane) Beta BHC
58-89-9	Hexachlorocyclohexane (Lindane) Gamma BHC
680-31-9	Hexamethylphosphoramide
302-01-2	Hydrazine
193-39-5	Indeno(1,2,3-cd)pyrene
-----	Isopropyl oils
-----	Lead compounds
301-04-2	Lead acetate
7446-27-7	Lead phosphate
129-15-7	2-Methyl-1-nitroanthraquinone
592-62-1	Methyl azoxymethyl acetate
3697-24-3	5-Methylchrysene
101-14-4	4,4'-Methylenebis(2-chloroaniline) (MBOCA)
838-88-0	4,4'-Methylenebis(2-methylaniline)
101-77-9	4,4-Methylene dianiline
13552-44-8	4,4-Methylenedianiline dihydrochloride
64091-91-4	4-(Methylnitrosamino)-1-(3-pyridyl)-1-butanone
2385-85-5	Mirex
139-91-3	5-(Morpholinomethyl)-3-amino)-2-oxazolidinone (furaltudone)
134-32-7	1-Napthylamine
C7440-02-0	Nickel and compounds (as nickel subsulfide or nickel refinery dust)
531-82-8	N-(4-(5-Nitro-2-furyl)-2-thiazolyl)acetamide
602-87-9	5-Nitroacenaphthene

CAS #	SUBSTANCE
1836-75-5	Nitrofen
	Nitrofurans
59-87-0	Nitrofurazone
555-84-9	1-(5-Nitrofurfurylidene)amino)-2-imidazolidinone
126-85-2	Nitrogen mustard N-oxide
302-70-5	Nitrogen mustard N-oxide hydrochloride
79-46-9	2-Nitropropane
924-16-3	N-Nitrosodi-n-butylamine
759-73-9	N-Nitroso-N-ethylurea (NEU)
615-53-2	N-Nitroso-N-methylurethane
621-64-1	N-Nitrosodi-n-propylamine
10595-95-6	N-Nitrosomethylethylamine
59-89-2	N-Nitrosomorpholine
86-30-6	N-Nitrosodiphenylamine
55-18-5	N-Nitrosodiethylamine (diethylnitrosoamine) (DEN)
62-75-9	N-Nitrosodimethylamine
2646-17-5	Oil orange SS
794-93-4	Panfuran S (dihydroxymethylfuratrizine)
87-86-5	Pentachlorophenol
127-18-4	Perchloroethylene (tetrachloroethylene)
63-92-3	Phenoxybenzamine hydrochloride
	N-Phenyl-2-napthylamine
—–	Polyaromatic hydrocarbons (PAH)
1336-36-3	Polychlorinated biphenyls (PCBs)
3761-53-3	Ponceau MX
	P(p)(alpha, alpha, alpha)-Tetra-chlorotoluene
1120-71-4	1,3-Propane sultone
75-56-9	Propylene oxide
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)
139-65-1	4,4'-Thiodianiline
1314-20-1	Thorium dioxide
95-80-7	2,4-Toluene diamine
584-84-9	2,4-Toluene diisocyanate
95-53-4	o-Toluidine
636-21-5	o-Toluidine hydrochloride
8001-35-2	Toxaphene
55738-54-0	Trans-2((Dimethylamino)methylimino)-5- (2-(5-nitro-2-furyl) vinyl-1,3,4-oxadiazole
79-01-6	Trichloroethylene
88-06-2	2,4,6-Trichlorophenol
75-01-4	Vinyl chloride

(2) TABLE II
CLASS A TOXIC AIR POLLUTANTS WITH ESTABLISHED ACCEPTABLE SOURCE IMPACT LEVELS

CAS #	SUBSTANCE	10-6 RISK ASIL MICRO-GRAMS/M^3 ANNUAL AVERAGE
75-07-0	Acetaldehyde	0.4500000
79-06-1	Acrylamide	0.0007700
107-13-1	Acrylonitrile	0.0150000
309-00-2	Aldrin	0.0002000
62-53-3	Aniline	6.3000000
C7440-38-2	Arsenic and inorganic arsenic compounds	0.0002300
1332-21-4	Asbestos (Note: fibers/ml)	0.0000044
71-43-2	Benzene	0.1200000
92-87-5	Benzidine and its salts	0.0000150
50-32-8	Benzo(a)pyrene	0.0004800
7440-41-7	Beryllium and compounds	0.0004200
111-44-4	Bis(2-chloroethyl)ether	0.0030000
117-81-7	Bis(2-ethylhexyl)phthalate (DEHP)	2.5000000
542-88-1	Bis(chloromethyl)ether	0.0000160
75-25-2	Bromoform	0.9100000
106-99-0	1,3-Butadiene	0.0036000
7440-43-9	Cadmium and compounds	0.0005600
56-23-5	Carbon tetrachloride	0.0670000
57-74-9	Chlordane	0.0027000
510-15-6	Chlorobenzilate	0.2000000
67-66-3	Chloroform	0.0430000
108-43-0	Chlorophenols	0.1800000
C7440-47-3	Chromium, hexavalent metal and compounds	0.0000830
—–	Coke oven emissions	0.0016000
3547-04-4	DDE (p,p'-dichlorodiphenyldichloroethylene)	0.1000000
50-29-3	DDT (1,1,1 Trichloro-2,2-Bis-(p-chlorophenyl)-ethane)	0.0100000
764-41-0	1,4-Dichloro-2-butene	0.0003800
106-46-7	1,4-Dichlorobenzene	1.5000000
91-94-1	3,3'-Dichlorobenzidine	0.0770000
107-06-2	1,2-Dichloroethane (ethylene chloride)	0.0380000
75-09-2	Dichloromethane (methylene chloride)	0.5600000
60-57-1	Dieldrin	0.0002200
119-93-7	3,3-Dimethyl benzidine	0.0038000
123-91-1	1,4-Dioxane	0.0320000
122-66-7	1,2-Diphenylhydrazine	0.0045000
106-89-8	Epichlorohydrin	0.8300000
106-93-4	Ethylene dibromide (dibromethane)	0.0045000
75-21-8	Ethylene oxide	0.0100000
96-45-7	Ethylene thiourea	1.0000000
50-00-0	Formaldehyde	0.0770000
76-44-8	Heptachlor	0.0007700
118-74-1	Hexachlorobenzene	0.0022000
58-89-9	Hexachlorocyclohexane (Lindane) gamma BHC	0.0026000
302-01-2	Hydrazine	0.0002000
C7440-02-0	Nickel and compounds (as nickel subsulfide or nickel refinery dust)	0.0021000
924-16-3	N-Nitrosodi-n-butylamine	0.0006300
55-18-5	N-Nitrosodiethylamine (diethylnitrosoamine)(DEN)	0.0000230
62-75-9	N-Nitrosodimethylamine	0.0000710
79-46-9	2-Nitropropane	0.0003700

CAS #	SUBSTANCE	10-6 RISK ASIL MICRO-GRAMS/M^3 ANNUAL AVERAGE
87-86-5	Pentachlorophenol	0.3300000
127-18-4	Perchloroethylene (tetrachloroethylene)	1.1000000
1336-36-3	Polychlorinated biphenyls (PCB)	0.0045000
75-56-9	Propylene oxide	0.2700000
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)	0.00000003
95-80-7	2,4-Toluene diamine	0.0110000
95-53-4	o-Toluidine	0.1400000
636-21-5	o-Toluidine hydrochloride	0.1400000
8001-35-2	Toxaphene	0.0031000
79-01-6	Trichloroethylene	0.5900000
88-06-2	2,4,6-Trichlorophenol	0.3200000
75-01-4	Vinyl chloride	0.0120000

(3) TABLE III CLASS A TOXIC AIR POLLUTANTS WITH SPECIAL ACCEPTABLE SOURCE IMPACT LEVELS

CAS #	SUBSTANCE	ASIL MICRO-GRAMS/M^3	AVERAGING TIME
-----	Primary aluminum smelter uncontrolled roof vent polyaromatic hydrocarbon (PAH) emissions (Note: Quantify according to WAC 173-460-050 (4)(d))	0.0013	Annual
61-82-5	Amitrole	0.06	24 hour
90-04-0	o-Anisidine	1.7	24 hour
126-99-8	&bgr;-Chloroprene	120	24 hour
94-75-7	2,4-D and esters	33	24 hour
78-87-5	1,2-Dichloropropane	4.0	24 hour
77-78-1	Dimethyl sulfate	1.7	24 hour
540-73-8	1,2-Dimethylhydrazine	4.0	24 hour
319-84-6	Hexachlorocyclohexane (Lindane) alpha BHC	1.7	24 hour
319-85-7	Hexachlorocyclohexane (Lindane) beta BHC	1.7	24 hour
-----	Lead compounds	0.5	24 hour
101-14-4	4,4'-Methylenebis (2-Chloroaniline) (MBOCA)	0.7	24 hour
101-77-9	4,4-Methylene dianiline	2.7	24 hour
-----	Polyaromatic hydrocarbon (PAH) emissions (Note: Quantify according to WAC 173-460-050 (4)(d))	0.00048	Annual
584-84-9	2,4-Toluene diisocyanate	0.12	24 hour

[Statutory Authority: Chapter 70.94 RCW. 94-03-072 (Order 93-19), § 173-460-150, filed 1/14/94, effective 2/14/94. Statutory Authority: RCW 70.94.331. 91-13-079 (Order 90-62), § 173-460-150, filed 6/18/91, effective 9/18/91.]

ATTACHMENT C – Chemicals Requiring Risk Management Plans

ATTACHMENT C – Chemicals Requiring Risk Management Plans

http://www.access.gpo.gov/nara/cfr/cfrhtml_00/Title_40/40cfr68_00.html

THIS DATA CURRENT AS OF THE FEDERAL REGISTER DATED JUNE 11, 2003

40 CFR - CHAPTER I - PART 68

§ 68.130 List of substances.

(a) Regulated toxic and flammable substances under section 112(r) of the Clean Air Act are the substances listed in Tables 1, 2, 3, and 4. Threshold quantities for listed toxic and flammable substances are specified in the tables.

(b) The basis for placing toxic and flammable substances on the list of regulated substances is explained in the notes to the list.

Table 1 to § 68.130_List of Regulated Toxic Substances and Threshold Quantities for Accidental Release Prevention [Alphabetical Order_77 Substances]

Chemical name	CAS No.	Threshold quantity (lbs)	Basis for listing
Acrolein [2-Propenal]...	107-02-8	5,000	b
Acrylonitrile [2- Propenenitrile].	107-13-1	20,000	b
Acrylyl chloride [2-Propenoyl chloride].	814-68-6	5,000	b
Allyl alcohol [2-Propen-l-ol].	107-18-61	15,000	b
Allylamine [2-Propen-l-amine].	107-11-9	10,000	b
Ammonia (anhydrous)...	7664-41-7	10,000	a, b
Ammonia (conc 20% or greater).	7664-41-7	20,000	a, b
Arsenous trichloride...	7784-34-1	15,000	b
Arsine......	7784-42-1	1,000	b
Boron trichloride [Borane, trichloro-].	10294-34-5	5,000	b
Boron trifluoride [Borane, trifluoro-].	7637-07-2	5,000	b
Boron trifluoride compound with methyl ether (1:1) [Boron, trifluoro [oxybis [metane]]-, T-4-.	353-42-4	15,000	b
Bromine......	7726-95-6	10,000	a, b
Carbon disulfide....	75-15-0	20,000	b
Chlorine......	7782-50-5	2,500	a, b
Chlorine dioxide [Chlorine oxide (ClO2)].	10049-04-4	1,000	c
Chloroform [Methane, trichloro-].	67-66-3	20,000	b
Chloromethyl ether [Methane, oxybis[chloro-].	542-88-1	1,000	b
Chloromethyl methyl ether [Methane, chloromethoxy-].	107-30-2	5,000	b
Crotonaldehyde [2-Butenal].	4170-30-3	20,000	b
Crotonaldehyde, (E)- [2- Butenal, (E)-].	123-73-9	20,000	b

Cyanogen chloride.... 506-77-4 10,000 c
Cyclohexylamine 108-91-8 15,000 b
[Cyclohexanamine].
Diborane...... 19287-45-7 2,500 b
Dimethyldichlorosilane [Silane, 75-78-5 5,000 b
dichlorodimethyl-].
1,1-Dimethylhydrazine 57-14-7 15,000 b
[Hydrazine, 1,1-dimethyl-].
Epichlorohydrin [Oxirane, 106-89-8 20,000 b
(chloromethyl)-].
Ethylenediamine [1,2- 107-15-3 20,000 b
Ethanediamine].
Ethyleneimine [Aziridine].. 151-56-4 10,000 b
Ethylene oxide [Oxirane].. 75-21-8 10,000 a, b
Fluorine...... 7782-41-4 1,000 b
Formaldehyde (solution).. 50-00-0 15,000 b
Furan....... 110-00-9 5,000 b
Hydrazine...... 302-01-2 15,000 b
Hydrochloric acid (conc 37% or 7647-01-0 15,000 d
greater).
Hydrocyanic acid.... 74-90-8 2,500 a, b
Hydrogen chloride (anhydrous) 7647-01-0 5,000 a
[Hydrochloric acid].
Hydrogen fluoride/Hydrofluoric 7664-39-3 1,000 a, b
acid (conc 50% or greater)
[Hydrofluoric acid].
Hydrogen selenide.... 7783-07-5 500 b
Hydrogen sulfide.... 7783-06-4 10,000 a, b
Iron, pentacarbonyl- [Iron 13463-40-6 2,500 b
carbonyl (Fe(CO)5), (TB-5-11)-
].
Isobutyronitrile 78-82-0 20,000 b
[Propanenitrile, 2-methyl-].
Isopropyl chloroformate 108-23-6 15,000 b
[Carbonochloridic acid, 1-
methylethyl ester].
Methacrylonitrile [2- 126-98-7 10,000 b
Propenenitrile, 2-methyl-].
Methyl chloride [Methane, 74-87-3 10,000 a
chloro-].
Methyl chloroformate 79-22-1 5,000 b
[Carbonochloridic acid,
methylester].
Methyl hydrazine [Hydrazine, 60-34-4 15,000 b
methyl-].
Methyl isocyanate [Methane, 624-83-9 10,000 a, b
isocyanato-].
Methyl mercaptan [Methanethiol] 74-93-1 10,000 b
Methyl thiocyanate [Thiocyanic 556-64-9 20,000 b
acid, methyl ester].
Methyltrichlorosilane [Silane, 75-79-6 5,000 b
trichloromethyl-].
Nickel carbonyl.... 13463-39-3 1,000 b
Nitric acid (conc 80% or 7697-37-2 15,000 b
greater).
Nitric oxide [Nitrogen oxide 10102-43-9 10,000 b
(NO)].
Oleum (Fuming Sulfuric acid) 8014-95-7 10,000 e

[Sulfuric acid, mixture with
sulfur trioxide] \1\.
Peracetic acid [Ethaneperoxoic 79-21-0 10,000 b
acid].
Perchloromethylmercaptan 594-42-3 10,000 b
[Methanesulfenyl chloride,
trichloro-].
Phosgene [Carbonic dichloride]. 75-44-5 500 a, b
Phosphine...... 7803-51-2 5,000 b
Phosphorus oxychloride 10025-87-3 5,000 b
[Phosphoryl chloride].
Phosphorus trichloride 7719-12-2 15,000 b
[Phosphorous trichloride].
Piperidine..... 110-89-4 15,000 b
Propionitrile [Propanenitrile]. 107-12-0 10,000 b
Propyl chloroformate 109-61-5 15,000 b
[Carbonochloridic acid,
propylester].
Propyleneimine [Aziridine, 2- 75-55-8 10,000 b
methyl-].
Propylene oxide [Oxirane, 75-56-9 10,000 b
methyl-].
Sulfur dioxide (anhydrous). 7446-09-5 5,000 a, b
Sulfur tetrafluoride [Sulfur 7783-60-0 2,500 b
fluoride (SF4), (T-4)-].
Sulfur trioxide.... 7446-11-9 10,000 a, b
Tetramethyllead [Plumbane, 75-74-1 10,000 b
tetramethyl-].
Tetranitromethane [Methane, 509-14-8 10,000 b
tetranitro-].
Titanium tetrachloride 7550-45-0 2,500 b
[Titanium chloride (TiCl4) (T-
4)-].
Toluene 2,4-diisocyanate 584-84-9 10,000 a
[Benzene, 2,4-diisocyanato-1-
methyl-] \1\.
Toluene 2,6-diisocyanate 91-08-7 10,000 a
[Benzene, 1,3-diisocyanato-2-
methyl-] \1\.
Toluene diisocyanate 26471-62-5 10,000 a
(unspecified isomer) [Benzene,
1,3-diisocyanatomethyl-] \1\.
Trimethylchlorosilane [Silane, 75-77-4 10,000 b
chlorotrimethyl-].
Vinyl acetate monomer [Acetic 108-05-4 15,000 b
acid ethenyl ester].

\1\ The mixture exemption in § 68.115(b)(1) does not apply to the
substance.

Note: Basis for Listing:

a Mandated for listing by Congress.
b On EHS list, vapor pressure 10 mmHg or greater.
c Toxic gas.
d Toxicity of hydrogen chloride, potential to release hydrogen
chloride,
and history of accidents.

e Toxicity of sulfur trioxide and sulfuric acid, potential to release sulfur trioxide, and history of accidents.

ATTACHMENT D – Influent Concentrations Used in Air Toxics Emission Modeling

ATTACHMENT D – Influent Concentrations Used in Air Toxics Emission Modeling (BASTE)

Compound	AMSA Influent Conc. (ug/L)
Acrolein **	0
Acrylonitrile	3.18
Benzene	3.09
Carbon tetrachloride	0.06
Chlorobenzene	3.38
Chloroform	5.87
1,4 Dichlorobenzene	6.97
Ethyl benzene	2.54
Ethylene dibromide *	0.02***
Ethylene dichloride (1,2 Dichloroethane) **	0
Formaldehyde *	0
Methylene chloride **	10.57
Methyl chloroform (1,1,1 Trichloroethane)	4.16
Styrene	1.19
Tetrachloroethylene (perchloroethylene)	8.52
Toluene	14.27
Trichloroethylene **	1.39
Vinyl chloride	0.02
Vinylidene chloride *	0.25
Xylenes	20.28
Total	***85.76***

* Not modeled in BASTE. Used mass balance approach to calculate the emission from liquid treatment processes, assuming all emitted from liquid surface.
** Emissions adjusted based on several POTWs inventories completed in 1990 for California State Law AB 2588.
***No value in AMSA data. Made assumption.

Source: *AMSA POTW Air Emissions Meeting Materials*. Washington D.C. December 1993.

ATTACHMENT E – Combustion Source Parameters

ATTACHMENT E – Combustion Source Parameters

The input parameters used in the dispersion model are based on current design knowledge. The input parameters include the exhaust stack height, diameter, velocity, and temperature of the exhaust gas. Air toxic modeling is typically conducted with the maximum potential emissions, which are determined by the design capacity of the treatment plant, in this case 54 mgd or 72 mgd. The source parameters used in the odor and air quality dispersion modeling for the 54 mgd treatment plant at the Route 9 site is presented in Table E1 and, for the Unocal site, in Table E2. The input parameters for the combustion sources are the same for 54 mgd and 72 mgd. The presence of a lid does not change the input parameters because the co-generation facility would not be under the lid.

TABLE E1
Combustion Source Parameters for a 54-mgd Treatment Plant at Route 9 Site

Source Parameters	Standby Diesel IC Engines	Cogen Turbines Generators	Hot Water Boilers
Stack Temperature, degrees F	916	829	200
Stack Temperature, degrees K	764	716	366
Stack Air flow, acfm	1,968	119,403	12,237
Stack Velocity, mps	12.7	16	11.7
Stack Velocity, fps	41.8	51.7	38.5
Stack Diameter, inches	12	84	18
Stack Diameter, feet	1	7	1.5
Stack Diameter, meters	0.3	2.1	0.5
Stack Height, meters	9.1	9.1	9.1
Stack Height, feet	30	30	30
Number of Stacks	2	2	3

TABLE E2
Combustion Source Parameters for a 54-mgd Treatment Plant at Unocal Site With and Without the Lid

Source Parameters	Standby Diesel IC Engines	Cogen Turbines Generators	Hot Water Boilers
Stack Temperature, degrees F	916	829	200
Stack Temperature, degrees K	764	716	366
Stack Air flow, acfm	1,968	129,353	12,237
Stack Velocity, mps	12.7	15	11.7
Stack Velocity, fps	41.8	48.8	38.5

TABLE E2
Combustion Source Parameters for a 54-mgd Treatment Plant at Unocal Site With and Without the Lid

Source Parameters	Standby Diesel IC Engines	Cogen Turbines Generators	Hot Water Boilers
Stack Diameter, inches	12	90	18
Stack Diameter, feet	1	7.5	1.5
Stack Diameter, meters	0.3	2.3	0.5
Stack Height, meters	9.1	9.1	9.1
Stack Height, feet	30	30	30
Number of Stacks	2	2	3

TABLE E3
Combustion Source Parameters for a 72-mgd Treatment Plant at Unocal Site With and Without the Lid

Source Parameters	Standby Diesel IC Engines	Cogen Turbines Generators	Hot Water Boilers
Stack Temperature, degrees F	916	829	200
Stack Temperature, degrees K	764	716	366
Stack Air flow, acfm	1,968	139,303	16,317
Stack Velocity, mps	12.7	16	11.7
Stack Velocity, fps	41.8	52.6	38.5
Stack Diameter, inches	12	90	18
Stack Diameter, feet	1	7.5	1.5
Stack Diameter, meters	0.3	2.3	0.5
Stack Height, meters	9.1	9.1	9.1
Stack Height, feet	30	30	30
Number of Stacks	2	2	4

ATTACHMENT F – Liquids and Solids Process Source Parameters

ATTACHMENT F – Liquids and Solids Process Source Parameters

The input parameters used in the model are based on current design knowledge. The input parameters include the exhaust stack height, diameter, velocity, and temperature of the exhaust gas. The source input parameters used in odor modeling of the odor prevention systems are the same parameters used for the air toxics modeling for those sources.

Odor modeling was conducted for the Phase 1 of the project (36 mgd) as well as 54 mgd and 72 mgd.

Route 9 Site

TABLE F1
Odor Prevention System Source Parameters for a 36-mgd Treatment Plant at Route 9 Site

Source Parameters	Influent Pump Station Odor prevention	Solids Handling odor prevention	Primary Odor Prevention	Secondary Odor Prevention
Stack Temperature, degrees F	68	68	68	68
Stack Temperature, degrees K	285	285	285	285
Stack Air flow, acfm	31,646	36,976	39,615	33,597
Stack Velocity, mps	11.8	13.8	14.8	12.5
Stack Velocity, fps	38.7	45.2	48.4	41.1
Stack Diameter, inches	50	50	50	50
Stack Diameter, feet	4.2	4.2	4.2	4.2
Stack Diameter, meters	1.3	1.3	1.3	1.3
Stack Height, meters	6.1	6.1	6.1	6.1
Stack Height, feet	20	20	20	20
Number of Stacks	2	2	3	4

TABLE F2
Odor Prevention System Source Parameters for a 54-mgd Treatment Plant at Route 9 Site

Source Parameters	Influent Pump Station Odor Prevention	Solids Handling Odor Prevention	Primary Odor Prevention	Secondary Odor Prevention
Stack Temperature, degrees F	68	68	68	68
Stack Temperature, degrees K	285	285	285	285
Stack Air flow, acfm	31,646	36,976	39,615	33,597

TABLE F2
Odor Prevention System Source Parameters for a 54-mgd Treatment Plant at Route 9 Site

Source Parameters	Influent Pump Station Odor Prevention	Solids Handling Odor Prevention	Primary Odor Prevention	Secondary Odor Prevention
Stack Velocity, mps	11.8	13.8	14.8	12.5
Stack Velocity, fps	38.7	45.2	48.4	41.1
Stack Diameter, inches	50	50	50	50
Stack Diameter, feet	4.2	4.2	4.2	4.2
Stack Diameter, meters	1.3	1.3	1.3	1.3
Stack Height, meters	6.1	6.1	6.1	6.1
Stack Height, feet	20	20	20	20
Number of Stacks	2	3	4	6

Unocal Site

TABLE F3
Odor Prevention System Parameters for a 36-mgd Treatment Plant at Unocal Site

Source Parameters	Influent Pump Station Odor Prevention	Solids Handling Odor Prevention	Primary Odor Prevention	Secondary Odor Prevention
Stack Temperature, degrees F	68	68	68	68
Stack Temperature, degrees K	285	285	285	285
Stack Air flow, acfm	31,646	36,976	39,615	34,618
Stack Velocity, mps	11.8	13.8	14.8	12.5
Stack Velocity, fps	38.7	45.2	48.4	41.1
Stack Diameter, inches	50	50	50	50
Stack Diameter, feet	4.2	4.2	4.2	4.2
Stack Diameter, meters	1.3	1.3	1.3	1.3
Stack Height, meters	6.1	6.1	6.1	6.1
Stack Height, feet	20	20	20	20
Number of Stacks	2	2	3	4

TABLE F4
Odor Prevention System Parameters for a 36-mgd Treatment Plant at Unocal Site with Structural Lid

Source Parameters	Influent Pump Station Odor Prevention	Solids Handling Odor Prevention	Primary Odor Prevention	Secondary Odor Prevention
Stack Temperature, degrees F	68	68	68	68
Stack Temperature, degrees K	285	285	285	285
Stack Air flow, acfm	31,646	36,976	39,615	34,618
Stack Velocity, mps	11.8	13.8	14.8	12.5
Stack Velocity, fps	38.7	45.2	48.4	41.1
Stack Diameter, inches	50	50	50	50
Stack Diameter, feet	4.2	4.2	4.2	4.2
Stack Diameter, meters	1.3	1.3	1.3	1.3
Stack Height, meters	6.1	6.1	6.1	6.1
Stack Height, feet	20	20	20	20
Number of Stacks	2	2	3	4

TABLE F5
Odor Prevention System Parameters for a 54-mgd Treatment Plant at Unocal Site

Source Parameters	Influent Pump Station Odor Prevention	Solids Handling Odor Prevention	Primary Odor Prevention	Secondary Odor Prevention
Stack Temperature, degrees F	68	68	68	68
Stack Temperature, degrees K	285	285	285	285
Stack Air flow, acfm	31,646	36,976	39,615	34,618
Stack Velocity, mps	11.8	13.8	14.8	12.5
Stack Velocity, fps	38.7	45.2	48.4	41.1
Stack Diameter, inches	50	50	50	50
Stack Diameter, feet	4.2	4.2	4.2	4.2
Stack Diameter, meters	1.3	1.3	1.3	1.3
Stack Height, meters	6.1	6.1	6.1	6.1
Stack Height, feet	20	20	20	20
Number of Stacks	2	3	4	6

TABLE F6
Odor Source Parameters for a 54-mgd Treatment Plant at Unocal Site with Structural Lid

Source Parameters	Influent Pump Station Odor Prevention	Solids Handling Odor Prevention	Primary Odor Prevention	Secondary Odor Prevention
Stack Temperature, degrees F	68	68	68	68
Stack Temperature, degrees K	285	285	285	285
Stack Air flow, acfm	31,646	36,976	39,615	34,618
Stack Velocity, mps	11.8	13.8	14.8	12.5
Stack Velocity, fps	38.7	45.2	48.4	41.1
Stack Diameter, inches	50	50	50	50
Stack Diameter, feet	4.2	4.2	4.2	4.2
Stack Diameter, meters	1.3	1.3	1.3	1.3
Stack Height, meters	6.1	6.1	6.1	6.1
Stack Height, feet	20	20	20	20
Number of Stacks	2	3	4	6

TABLE F7
Odor Source Parameters for a 72-mgd Treatment Plant at Unocal Site

Source Parameters	Influent Pump Station Odor Prevention	Solids Handling Odor Prevention	Primary Odor Prevention	Secondary Odor Prevention
Stack Temperature, degrees F	68	68	68	68
Stack Temperature, degrees K	285	285	285	285
Stack Air flow, acfm	31,646	36,976	39,615	34,618
Stack Velocity, mps	11.8	13.8	14.8	12.5
Stack Velocity, fps	38.7	45.2	48.4	41.1
Stack Diameter, inches	50	50	50	50
Stack Diameter, feet	4.2	4.2	4.2	4.2
Stack Diameter, meters	1.3	1.3	1.3	1.3
Stack Height, meters	6.1	6.1	6.1	6.1
Stack Height, feet	20	20	20	20
Number of Stacks	2	4	5	8

TABLE F8
Odor Source Parameters for a 72-mgd Treatment Plant at Unocal with Structural Lid

Source Parameters	Influent Pump Station Odor Prevention	Solids Handling Odor Prevention	Primary Odor Prevention	Secondary Odor Prevention
Stack Temperature, degrees F	68	68	68	68
Stack Temperature, degrees K	285	285	285	285
Stack Air flow, acfm	31,646	36,976	39,615	34,618
Stack Velocity, mps	11.8	13.8	14.8	12.5
Stack Velocity, fps	38.7	45.2	48.4	41.1
Stack Diameter, inches	50	50	50	50
Stack Diameter, feet	4.2	4.2	4.2	4.2
Stack Diameter, meters	1.3	1.3	1.3	1.3
Stack Height, meters	6.1	6.1	6.1	6.1
Stack Height, feet	20	20	20	20
Number of Stacks	2	4	5	8

ATTACHMENT G – Acronyms and Abbreviations

ATTACHMENT G – Acronyms and Abbreviations

acfm = actual cubic feet per minute

ACH = air changes per hour

AMSA = American Metropolitan Sewerage Agencies

ASIL = acceptable source impact level

BACT = best achievable control technology

BASTE = Bay Area Sewage Toxics Emissions

BGT = gravity belt thickeners

BTEX = benzene, toluene, ethlybenzene, and xylenes

Btu = British thermal units

cfm = cubic feet per minute

cfm/ft^2 = cubic feet per minute per square foot

CFR = Code of Federal Regulations

CO = carbon monoxide

D/T = dilution to threshold

DEM = Digital Elevation Map

DRO = diesel range organic

Ecology = Washington Department of Ecology

EIS = Environmental Impact Statement

EPA = United States Environmental Protection Agency

fps = feet per second

HAP = hazardous air pollutant

H_2S = hydrogen sulfide

IC = internal combustion

ISEST3 = Industrial Source Complex Short-Term

g/s = grams per second

GRO = gasoline range

kg/m^3 = kilograms per cubic meter

kW = kilowatts

HO = heavy-oil range

lb/yr = pounds per year

MACT = maximum achievable control technology

mgd = millions gallons per day

mg/L = milligrams per liter

mps = meters per second

m^3/s = cubic meters per second

MW = megawatts

MMBtu = million British thermal units

NA = not applicable

NAAQS = National Ambient Air Quality Standards

NESHAP = National Emission Standards for Hazardous Air Pollutants

NSPS = New Source Performance Standards

NFPA = National Historic Preservation Act

NH_3 = ammonia

NO = nitric oxide

NOC = Notice of Construction

NO_2 = nitrogen dioxide

NO_x = nitrogen oxides

NSR = new source review

O&M = operations and maintenance

OSHA = Occupational Safety and Health Act

PAH = polycyclic aromatic hydrocarbon

PEEP = Pooled Emission Estimation Program

PM = particulate matter

PM_{10} = particulate matter less than 10 microns in diameter

PM_{25} = particulate matter less than 2.5 microns in diameter

POTW = publicly owned treatment works

ppm = parts per million

ppbV = parts per billion by volume

PS Clean Air = Puget Sound Clean Air Agency

PSD = Prevention of Significant Deterioration

RMP = Risk Management Plan

RTO = regenerative thermal oxidizer

SIP = State Implementation Plan

SO_x = sulfur oxides

SQER = small quantity emission rate

TAP = toxic air pollutant

TBACT = best achievable control technology for toxics

TSP = total suspended particulate matter

$\mu g/m^3$= microgram per cubic meter

USGS = United States Geological Survey

UV = ultraviolet

VOC = volatile organic compound